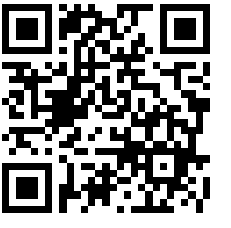
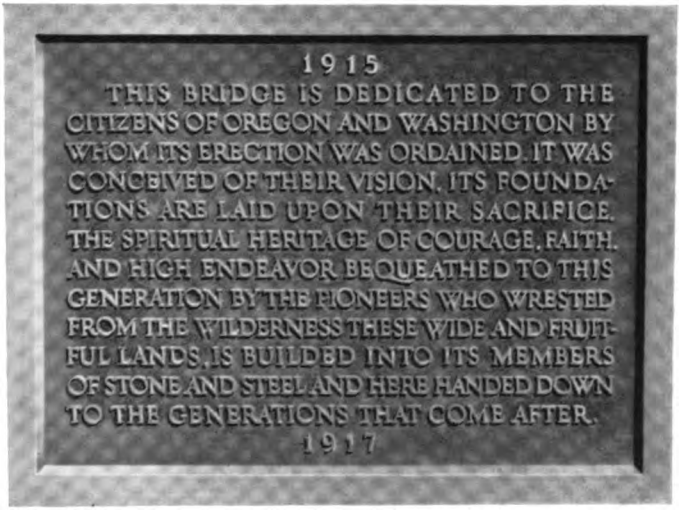


THE
COLUMBIA RIVER
INTERSTATE BRIDGE

FINAL REPORT



THE COLUMBIA RIVER INTERSTATE BRIDGE
As seen from Hayden Island, looking toward Vancouver. Length 3,530 feet. Taken at time of high water.

FINAL REPORT

The Columbia River Interstate Bridge

Vancouver, Washington to Portland, Oregon

FOR

Multnomah County, Oregon
Clarke County, Washington

BY

JOHN LYLE HARRINGTON AND ERNEST E. HOWARD

CONSULTING ENGINEERS, KANSAS CITY, MO.

THE COLUMBIA RIVER INTERSTATE BRIDGE COMMISSION

PERSONNEL

FROM NOVEMBER, 1913, TO JANUARY, 1915.

Rufus C. Holman, Chairman;
W. L. Lightner,
D. V. Hart,
Governor Oswald West,
} Commissioners for Multnomah County.

A. Rawson,
W. S. Lindsay,
S. N. Secrist,
} Commissioners for Clarke County.

W. N. Marshall, Secretary.

FROM JANUARY, 1915, TO JANUARY, 1917.

Rufus C. Holman, Chairman;
W. L. Lightner,
Philo M. Holbrook,
Governor Jas. B. Withycombe,
} Commissioners for Multnomah County.

A. Rawson,
W. S. Lindsay,
John P. Kiggins,
} Commissioners for Clarke County.

AFTER JANUARY, 1917.

Rufus C. Holman, Chairman;
Philo M. Holbrook,
A. A. Muck,
Governor Jas. B. Withycombe,
} Commissioners for Multnomah County.

M. E. Carson,
Abe Miller,
John P. Kiggins,
} Commissioners for Clarke County.

Legal Advisers: Walter H. Evans, Arthur A. Murphy, James O. Blair, L. M. Burnett.

GENERAL CALENDAR OF EVENTS

August	12, 1913,	Clarke County, Washington voted bonds for construction.
November	4, 1913,	Multnomah County, Oregon, voted bonds for construction.
November	29, 1913,	The Columbia River Interstate Bridge Commission organized.
December	29, 1913,	Commission selected Engineers.
December	29, 1913,	Commission directed Engineers to prepare preliminary plans and to make a report recommending a location for bridge and approaches.
January	31, 1914,	Bill authorizing construction passed Congress.
March	26, 1914,	Engineers completed preliminary studies, and recommended location of structure.
March	30, 1914,	Commission adopted report and located structure.
April	13, 1914,	Engineers made application to Secretary of War for permit for construction.
April	20, 1914,	Public hearing of War Department to consider proposed plans.
June	12, 1914,	Tentative approval of plans given by Secretary of War.
		Progress delayed by financial disturbance due to commencement of war in Europe.
November,	1914,	Clarke County sold $250,000 bridge bonds.
November	9, 1914,	Multnomah County sold $250,000 bridge bonds.
December,	1914,	Clarke County sold $250,000 bridge bonds.
December	14, 1914,	Multnomah County sold $1,000,000 bridge bonds.

January	11, 1915,	Engineers presented final detailed plans and specifications.
January	11, 1915,	Commission adopted plans and specifications and ordered work advertised.
February	23, 1915,	Commission received bids for all principal construction work.
February	27, 1915,	Commission awarded contracts for principal construction work.
March	6, 1915,	Actual construction formally started.
April	2, 1915,	Engineers presented and Commission adopted plans and specifications for Derby Street approach embankment.
April	26, 1915,	Commission received bids for Derby Street approach embankment.
April	30, 1915,	Commission awarded contract Derby Street approach embankment.
June	16, 1915,	Final approval of plans given by Secretary of War.
August	18, 1916,	Engineers presented and Commission adopted plans and specifications for pavement of approach embankments.
September	19, 1916,	Commission received bids for pavement of approach embankments.
September	20, 1916,	Commission awarded contract for pavement of approach embankments.
October	27, 1916,	Commission awarded contract making purchase of materials for lighting system.
March	6, 1917,	Commission awarded contract for constructing lighting system.
February	14, 1917,	Bridge formally opened to traffic.
August	2, 1917,	Engineers rendered final estimate for last contract.

CONTENTS

ILLUSTRATIONS

1915

THIS BRIDGE IS DEDICATED TO THE CITIZENS OF OREGON AND WASHINGTON BY WHOM ITS ERECTION WAS ORDAINED. IT WAS CONCEIVED OF THEIR VISION, ITS FOUNDATIONS ARE LAID UPON THEIR SACRIFICES. THE SPIRITUAL HERITAGE OF COURAGE, FAITH AND HIGH ENDEAVOR BEQUEATHED TO THIS GENERATION BY THE PIONEERS WHO WRESTED FROM THE WILDERNESS THESE WIDE AND FRUITFUL LANDS, IS BUILDED INTO ITS MEMBERS OF STONE AND STEEL AND HERE HANDED DOWN TO THE GENERATIONS THAT COME AFTER.

1917

THE COLUMBIA RIVER INTERSTATE BRIDGE BUILT BY THE PEOPLE OF CLARKE COUNTY WASHINGTON, AND MULTNOMAH COUNTY OREGON, UNDER DIRECTION OF THE COLUMBIA RIVER INTERSTATE BRIDGE COMMISSION, RUFUS C. HOLMAN, CHAIRMAN, COMMISSIONERS FOR CLARKE COUNTY, A. RAWSON, CHAIRMAN, W S. LINDSAY, JOHN P. KIGGINS. COMMISSIONERS FOR MULTNOMAH COUNTY, W. L. LIGHTNER, CHAIRMAN, PHILO HOLBROOK, RUFUS C. HOLMAN, THE GOVERNOR OF OREGON. LEGAL ADVISERS, WALTER H. EVANS, JAMES O. BLAIR, ARTHUR MURPHY. CONSTRUCTION BEGAN MARCH, 1915. COMPLETED JANUARY, 1917.

THE COLUMBIA RIVER INTERSTATE BRIDGE DESIGNED AND BUILT UNDER DIRECTION OF JOHN LYLE HARRINGTON, KANSAS CITY, MO., WADDELL & HARRINGTON (NOW DISSOLVED), LOUIS R. ASH & ERNEST E. HOWARD, CONSULTING ENGINEERS. F. M. CORTELYOU, RESDT. ENGR.

CONTRACTORS: MANUFACTURE OF STEEL, AMERICAN BRIDGE COMPANY, NORTHWEST STEEL COMPANY. ERECTION, PORTER BROTHERS. FOUNDATIONS, THE PACIFIC BRIDGE COMPANY. EMBANKMENTS, TACOMA DREDGING COMPANY, STANDARD AMERICAN DREDGING COMPANY. PAVEMENTS, WARREN CONSTRUCTION COMPANY.

"OF ALL INVENTIONS, THE ALPHABET AND THE PRINTING PRESS ALONE EXCEPTED, THOSE INVENTIONS WHICH ABRIDGE DISTANCE HAVE DONE MOST FOR THE CIVILISATION OF OUR SPECIES. EVERY IMPROVEMENT OF THE MEANS OF LOCOMOTION BENEFITS MANKIND MORALLY AND INTELLECTUALLY AS WELL AS MATERIALLY, AND NOT ONLY FACILITATES THE INTERCHANGE OF THE VARIOUS PRODUCTIONS OF NATURE AND ART, BUT TENDS TO REMOVE NATIONAL AND PROVINCIAL ANTIPATHIES, AND TO BIND TOGETHER ALL THE BRANCHES OF THE GREAT HUMAN FAMILY."

—MACAULAY.

THE COLUMBIA RIVER INTERSTATE BRIDGE. TOTAL LENGTH OF BRIDGE AND APPROACHES 4½ MILES. COMPLETED JANUARY, 1917. TOTAL COST $1,750,000. THE BRIDGE OVER THE COLUMBIA RIVER 3,531 FT. LONG, CONSISTS OF ONE 50 FT. SPAN, THREE 275 FT. SPANS AND TEN 265 FT. SPANS; AND CONTAINS 7,350 TONS OF STEEL, 17,650 SQ. YDS. OF REINFORCED CONCRETE DECK, 15,000 SQ. YDS. OF PAVEMENT, 21,600 CU. YDS. OF PIERS SUPPORTED ON PILES EXTENDING TO 160 FT. BELOW ROADWAY. THE TOWERS EXTEND TO 190 FT. ABOVE ROADWAY.

"YOU MAY TELL ME THAT MY VIEWS ARE VISIONARY, THAT THE DESTINY OF THIS COUNTRY IS LESS EXALTED, THAT THE AMERICAN PEOPLE ARE LESS GREAT THAN I THINK THEY ARE OR OUGHT TO BE. I ANSWER, IDEALS ARE LIKE STARS, YOU WILL NOT SUCCEED IN TOUCHING THEM WITH YOUR HANDS, BUT LIKE THE SEA-FARING MAN ON THE DESERT OF WATERS, YOU CHOOSE THEM AS YOUR GUIDES AND FOLLOWING THEM, YOU REACH YOUR DESTINY."

—CARL SCHURZ.

THE COLUMBIA RIVER INTERSTATE BRIDGE APPROACHES

THE BRIDGE OVER OREGON SLOUGH, 1,137 FT. LONG, CONSISTS OF ONE 115 FT. SPAN AND TEN 100 FT. SPANS. THE BRIDGE OVER COLUMBIA SLOUGH IS 307 FT. LONG AND CONSISTS OF FOUR 75 FT. SPANS. THESE BRIDGES CONTAIN 1,725 TONS OF STEEL, 7,150 SQ. YDS. OF REINFORCED CONCRETE DECK, 6,100 SQ. YDS. OF PAVEMENT, 5,700 CU. YDS. OF PIERS. THE EMBANKMENTS HAVE A COMBINED LENGTH OF 18,000 FT. AND CONTAIN 1,500,000 CU. YDS. PAVEMENT ON EMBANKMENTS 58,000 SQ. YDS.

"THEREFORE WHEN WE BUILD, LET US THINK THAT WE BUILD FOREVER. LET IT NOT BE FOR PRESENT DELIGHT, NOR FOR PRESENT USE ALONE. LET IT BE SUCH WORK AS OUR DESCENDANTS WILL THANK US FOR, AND LET US THINK, AS WE LAY STONE ON STONE, THAT A TIME IS TO COME WHEN THOSE STONES WILL BE HELD SACRED BECAUSE OUR HANDS HAVE TOUCHED THEM, AND THAT MEN WILL SAY AS THEY LOOK UPON THE LABOR, AND WROUGHT SUBSTANCE OF THEM, 'SEE THIS OUR FATHERS DID FOR US.'"

—RUSKIN.

These inscriptions on bronze tablets are on the entrance columns of the bridge.

VANCOUVER END OF COLUMBIA RIVER BRIDGE.

THE OREGON SLOUGH BRIDGE.
As seen from Hayden Island, looking toward Portland. Length 1,140 feet.

The Columbia River Interstate Bridge Commission,
The Commissioners of Multnomah County, Oregon,
The Commissioners of Clarke County, Washington.

GENTLEMEN:

The Columbia River Interstate Bridge between Vancouver, Washington, and Portland, Oregon, is completed and in service. We now respectfully submit our final report upon all the principal matters pertaining to its construction. Beginning with our report of March 26, 1914, recommending the adopted location of the bridge and its approaches, we have made many reports to you, including regular weekly reports showing the progress of the work included under each contract, monthly reports and estimates showing the amounts earned by each contractor, reports relating to tests and inspection of materials and workmanship, and various special reports on rights of way, franchises, operation, and similar matters. These are all in your files and available for reference; hence their details will not be repeated; but this report will be confined to the more important engineering and business features of the whole project, including your own actions.

The efficient and harmonious working of the Columbia River Interstate Bridge Commission has been largely responsible for the success and celerity with which the work has been carried out. Although composed of the Commissions of two counties situated in different states, having different laws and different interests, differing greatly in wealth and population, and contributing different sums of money, we have found the Commissioners, while jealous of the rights and tenacious of the prerogatives of the community each represented, always fair and reasonable and ready to find some common equable ground for adjusting differences so as to permit the work to go forward. The eminently satisfactory progress and conclusion of the work could not have been attained except for the promptness of the Commission in deciding the many questions presented, and for the unwavering firmness with which the Commission adhered to a position adopted or a policy determined. We have been highly gratified to have the Commission adopt, we believe without exception, our every recommendation.

The care and attention to detail which marked the execution of the design and other technical features are evident in the

completed structure, and are also indicated in the financial statement. Beginning with an amount of money insufficient, according to early reports, even for a bridge with a 24-ft. roadway and one approach on the Oregon side (main bridge, $1,660,700; Oregon approach, $420,000), the design both of substructure and superstructure proved to be so fitting and economical and conditions for construction according to these designs so favorable, that the bridge was completed with a 38-ft. roadway, with concrete floor, wholly fire-proof, and with two approaches on the Oregon side, within the funds ($1,790,000) and with a balance of the original fund left with each county (totaling $56,000).

But we have attempted to serve you broadly; not alone along technical lines, but in the administration and in the general business of buying a bridge and getting full value for the money spent; in the study of the broad and general needs of the public for transportation facilities, which was a large factor in determining the recommendation for the location of the bridge and approaches, in assisting with negotiations for the acquirement of the rights-of-way and other properties; in drafting tentative franchises for street railway operation; in the determination of tolls to be charged; in arranging a scheme of organization for the operating department, and in the general problems of administration. We have tried always to give the same careful and detailed attention to every question submitted to us as we have to essentially engineering problems. In this connection, we would like to add, that never in a long experience of similar undertakings have we known more sympathetic, broad-minded and intelligent co-operation from a legal department than you have received and we have enjoyed at the hands of Mr. Walter H. Evans, District Attorney, and his associates.

The Columbia River Interstate Bridge is a great public work carried through with intelligence, economy and efficiency. It should always be a source of gratification and pride to the members of the Columbia River Interstate Bridge Commission, for it cannot but long be known as a monument to their public service.

Respectfully submitted,

JOHN LYLE HARRINGTON,
ERNEST E. HOWARD,
Consulting Engineers.

GENERAL STATEMENT

The Columbia River Interstate Bridge is in some respects unique as a public work; unique in the persistence and unanimity of the people of Clarke County and Multnomah County in providing for its construction; unique in the celerity of the public officers in organizing and pushing forward with the work; unique in the rapidity of construction; unique in the fact that the entire work originally contemplated and a complete additional approach were constructed within the money provided; and unique in proving to be a paying investment, with a constantly increasing income. It is also the first and the only highway bridge over the Columbia River from far above the mouth of the Snake River to the Pacific Ocean.

For many years the Columbia River was crossed only by ferries. At length a railroad bridge was built at Vancouver, and one or two up the river, but the highway traffic was still confined to the ferries. With increase of population and of travel, and the widespread and growing realization of the need for improved highways, there came to be a general recognition of the necessities for and of the advantages certain to follow the construction of a highway bridge over the Columbia River at Vancouver. Actively advocated by an increasing number of men well known in Oregon and Washington, the demand for a bridge became crystallized, during the early months of 1912, in a movement by the Commercial Club of Vancouver, Washington, and the then Commercial Club of Portland, Oregon, which finally resulted in the enactment of laws by the States of Washington and Oregon permitting Clarke County, Washington, and Multnomah County, Oregon, to provide funds by voting bonds and to join in the construction of a bridge. (Laws of Washington 1913, Chapter 56, page 168; Laws of Oregon 1913, Chapter 349, page 701.) Active campaigns for immediate action under these statutes were conducted by the two organizations and received hearty endorsement from the citizenship, for on August 12, 1913, Clarke County voted overwhelmingly for the issuance of $500,000 of bonds, and on November 4, 1913, Multnomah County followed suit by providing for an issue of bonds of $1,250,000.

The Acts provided that the work should be carried forward by the regular County officers, except that in Oregon the Gov-

ernor of the State was to act with the County Commissioners for certain purposes. The two Boards of County Commissioners met in joint session November 29, 1913, and for convenience of action organized themselves into the Columbia River Interstate Bridge Commission, with Rufus C. Holman as permanent chairman, and with W. N. Marshall, auditor of Clarke County, as secretary. A simple arrangement that all acts of the joint Commission would be ratified in due order by each separate Board made it possible for the two Boards to act in unison. The personnel of the Commission throughout the whole work is given on a preceding page.

The Commission took up as its first action the selection of engineers for the work, and, after a month of investigation and consideration, on December 29, 1913, your Engineers were chosen from the dozen or more applicants. This prompt and timely action in employing engineers had much to do with the success of the work, for the Engineers found the Commission with open minds, without preconceived ideas or set notions, and were able to undertake the solution of the problems from a purely scientific standpoint. The Commission directed the Engineers to proceed immediately with the necessary surveys and studies, and to make a report recommending a location of the bridge over the river and for an approach in Vancouver and one on the Portland side. After two and a half months spent in making surveys, studies of traffic, estimates of cost, actively assisting in securing options for rights-of-way for each location, and after considering in every way four possible approaches on the Portland side and four in Vancouver, your Engineers reported their findings and recommended locations on March 26, 1914. In order to determine definitely the costs of right-of-way for each approach the Commissioners in Clarke County and Mr. J. Fred Larson, acting for Multnomah County, had secured written options on the lands required for all approaches at definite prices. Definite and complete cost comparisons could thus be made. After a few days of consideration, with public hearings for citizens who wished to be heard concerning approaches, your Commission adopted the Engineers' recommendations and fixed the bridge approaches to be at Union Avenue on the Portland side and at Washington Street on the Vancouver side, subject to the conditions that the city of Portland should extend Union Avenue to the city limits and also should secure from the Portland Railway Light and Power Company an adequate release of their exclusive rights over a certain strip of land which that company owned in the street, and to provide for "common user" over

the tracks of the company in that strip. The city of Portland later fulfilled both of your conditions.

The Engineers had, in the meantime, been occupied with preliminary borings and soundings for the several bridges. As soon as the locations were fixed these investigations were pushed to conclusion and preliminary plans for the bridges over the main channel of the Columbia River, over Oregon Slough and over Columbia Slough were prepared and copies were submitted to the Secretary of War with applications for permits for construction. The customary public hearing before the Engineers of the War Department was held in Portland on April 20th, and on June 12th, 1914 tentative approval of the plans was secured from the Secretary of War. The preparation of final detailed plans and specifications was immediately undertaken.

The Legal Department had been proceeding during the same months and had taken the necessary steps by certain friendly suits to establish the validity of the bond issues to such good purpose that on July 14, 1914, the last necessary action was concluded by a favorable decision of the Supreme Court of Oregon relative to the Oregon bonds. The financial disturbance caused by the beginning of the war in Europe in August, 1914, made it impracticable to dispose of the bonds immediately, but in November each County satisfactorily placed a portion of its bonds, and preliminary funds were secured. Upon advice of your Engineers, however, that in the still unsettled condition of the money market and the uneasiness of contractors in becoming largely involved unless all funds were provided, the remaining bonds were placed in December, 1914, so that the entire funds were on hand to pay for the work. The correctness of the Commission's action in this matter was thoroughly demonstrated when the bids for the work were received, for they were unexpectedly and agreeably low.

On January 11, 1915, the final detailed plans and specifications for the construction were submitted by the Engineers, were approved and adopted by the Commission, and advertisements for bids ordered. On February 23, 1915, bids were received from twenty-four contractors. Acting on previous instructions from your Commission, and as later described, your Engineers had prepared complete plans for two different designs for the main structure over the Columbia River channel, one containing a movable span of the swing type, and the other one of the vertical lift type. The lowest combination of bids received for each design showed a saving by the use of the vertical lift type of

movable span, amounting to $70,013.60. On this showing, your Commission on February 27, 1915, adopted the design containing that type and awarded contracts for the construction of the bridges as follows:

Contract No. 1—To the United States Steel Products Company, of San Francisco, for the manufacture of the superstructure metal work of the Columbia River bridge.

Contract No. 2—To Porter Brothers, of Portland, for the erection of the superstructure metal work of the Columbia River bridge.

Contract No. 5—To the Northwest Steel Company, of Portland, for the manufacture of the superstructure metal work of the Oregon and Columbia Slough bridges.

Contract No. 6—To Porter Brothers, of Portland, for the erection of the superstructure metal work of the Oregon and Columbia Slough bridges.

Contract No. 7—To the Pacific Bridge Company, of Portland, for the foundations of the Columbia River bridge.

Contract No. 9—To the Pacific Bridge Company, of Portland, for the foundations of the Oregon and Columbia Slough bridges.

Contract No. 10—To the Tacoma Dredging Company, of Tacoma, Washington, for the approach embankments.

Contract No. 11—To the Warren Construction Company, of Portland, for the concrete deck slabs and paving on all the steel bridges.

The bids received at this time for the paving of the embankments were rejected owing to the small number of bids and the feeling that those received were unduly high on account of the length of time, about eighteen months, that must elapse before work on this contract could be started.

The bids received on all of the contracts awarded at this time were considerably lower than anticipated, so that there remained sufficient funds from the proceeds of the bond issues for the construction of improvements not included in the original plans. The largest of these was the approach embankment to the bridge from Derby Street, which serves a section of Portland distant from Union Avenue, and for which there had been an insistent demand from the inception of the project. Your Engineers submitted plans and specifications for the construction of this approach embankment on April 2, 1915, at which time they were approved by your Commission and the advertisement for

bids ordered. Bids were received on April 26, 1915, and on April 30, 1915, contract was awarded to the Standard American Dredging Company.

The awarding of the contract for the paving of embankments was delayed partly from caution and partly by causes beyond the control of your Commission or your Engineers. Your Engineers deemed it advisable to wait until after the high water of 1916 in order to observe the effects of such high water on the embankments, and so as not unnecessarily to subject permanent pavement to possible settlements which might occur to

THE COLUMBIA RIVER INTERSTATE BRIDGE
As seen from the downstream side, Vancouver end, looking toward Portland. Ordinary stage of water.

the new embankment with the first high water. This high water occurred several weeks later than its expected time, was of more than the ordinary height and of unusual duration. Moreover, on account of questions relative to the granting of a franchise to the Portland Railway Light and Power Company for the use of the bridge, it was impossible to decide upon the extent of the paving to be done on the embankments till late in the summer of 1916. On August 18, 1916, your Engineers submitted plans and specifications governing the paving of all embankments, provid-

ing for the taking of bids upon various types in order to secure the fullest competition, and providing also for various widths of pavement pending the settlement of franchise matters over the approaches and the decision of your Commission as to the paved width to be provided. Bids were received on September 19, 1916, and agreement having been reached meanwhile with the Portland Railway, Light and Power Company, whereby it would use the Columbia River bridge and Vancouver approach, but not the Union Avenue approach, your Commission decided to pave a 38-ft. width over Hayden Island, 30 ft. on the Union Avenue approach south of Oregon Slough and 18 ft. on the Derby Street approach. Contract was awarded on September 20, 1916, to the Warren Construction Company for bitulithic pavement on broken stone base for Union Avenue approach, macadam for Derby Street approach and bitulithic pavement in Vancouver.

The awarding of this contract provided for the last item of construction with the exception of the lighting system. Contracts for the furnishing of the main items of material for this system were awarded on October 27, 1916, to the United States Steel Products Company and the Pacific States Electric Company, and on March 6, 1917, contract for the installation of the lighting system was awarded to Nelson & Brown.

The various contractors assembled materials and equipment immediately after the signing of their respective contracts, and construction proceeded as rapidly as the river conditions would permit. Although practically all of the contractors were working at the same time, the whole work progressed smoothly and substantially without friction or interference under the capable and efficient supervision of the Engineers' representative in charge, Mr. Frank M. Cortelyou, Resident Engineer.

Following the signing of the contracts, your Commission was occupied with the final acquirement of the lands for right-of-way, with consideration through committees of franchises and of matters relating to management of the property after the construction should be finished, with the determination of the income required for proper operation and of toll charges necessary to provide it. Mr. Evans concluded that certain special legislation was desirable in Oregon to simplify the control of the property and the passage of suitable bills by the Legislature of the State was secured. The Commission met from time to time to receive reports of progress from the Engineers and to approve for payment the monthly payment estimates to the contractors for the work done. The public necessities made it appear desir-

able to the Commission to provide for traffic at the earliest date possible, and the bridge was opened to traffic as soon as the pavement of the roadways had been completed, and several weeks before the last of the work, comprising the finishing touches to the structure, had been carried out.

The following pages include a general description of the bridge and approaches, and information concerning the loadings for which the bridge is designed; a description of some of the interesting construction features, a tabulation of the quantities in the structure and of the costs and classification of costs; a summary of the franchise provisions of the Portland Railway, Light and Power Company; and, finally, suggestions for maintenance and operation of the structure, which should come to the attention of the Commission.

GENERAL DESCRIPTION OF BRIDGE

The Columbia River Interstate Bridge and Approaches extends across the valley of the Columbia River from the city limits of Vancouver, Washington, to the city limits of Portland, Oregon, a distance of three and a quarter miles, and includes about 5,000 lineal ft. of steel bridge structures and 12,000 ft. of embankment, in addition to which there is a secondary embankment on the Oregon side about 6,000 ft. long. The bridge and approaches provide a roadway for street traffic and tracks for street cars, and over steel structures a sidewalk. At times of extreme flood, the high water covers the entire three-mile width of valley and extends from Vancouver to the city limits of Portland.

The Columbia River at the bridge site is 3,500 ft. wide, with a maximum depth of 30 ft. at extreme low water and with variation from extreme low to extreme high water of 33 ft. The water rises each spring to about 20 ft. and about once in four years to 25 ft. So far as known it has reached 33 ft. only once. The bed of the river consists of sand, with small amounts of gravel, extending to great depths. At the north shore very compact cemented gravel is found a few feet below low water, dropping off to 100 ft. below at about 700 ft. from the north shore. Over the remainder of the river only sand with some gravel was found to depths of more than 100 ft.

The Oregon Slough forms an important secondary channel, particularly for flood conditions. It is about 1,000 ft. wide, and

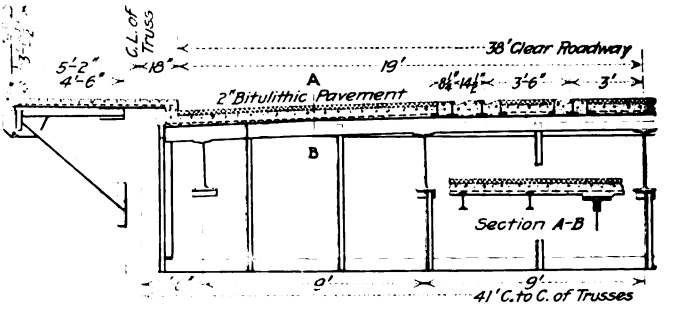
25 ft. deep, and is separated from the main river by an island about 1,500 ft. wide. The U. S. Government has built a dyke some distance above the bridge site and the island to divert practically all of the low water flow down the main channel of the river, the top of the dike being about 6 ft. above low water. The bed of this slough is principally sand. The Columbia Slough provides some drainage near the Oregon side of the valley, is about 300 ft. wide and 20 ft. deep at low water. The bottom is of very soft clay and sand; hard and compact gravel is found about 80 ft. below low water. The average elevation of the ground across the river valley is from 12 to 15 ft. above low water, so that much of it is inundated at every high water period.

The roadway is 38 ft. wide between curbs on the steel spans, 38 ft. wide between rock shoulders across Hayden Island, 30 ft. wide on the balance of the Union Avenue approach and 18 ft. wide on the Derby Street approach. Over the steel spans there is one sidewalk 5 ft. wide. Double track street car tracks for both standard and narrow gauges are placed in the middle of the roadway on the steel structure, spaced 10 ft. 8½ ins. center to center. The vertical clearance on the truss spans is 21 ft. 6 ins. The roadway on the steel structures across Hayden Island and on the Union Avenue approach is paved with bitulithic pavement and on the Derby Street approach with macadam.

The bridge over the Columbia River consists of a series of through riveted truss spans with curved top chords; three spans 275 ft. long and ten spans 265 ft. long, together with a small deck girder span at the Vancouver end, making a total length of 3,531 ft. 5⅞ ins. between end shoes. Provision for navigation on the river is made by a vertical lift span. The central of three 275 ft. spans is arranged to lift between towers on the other two, so as to afford a channel 250 ft. wide at right angles to the current of the river and 150 ft. high above ordinary high water.

For the through spans the trusses are spaced 41 ft. center to center, with the roadway between and the sidewalk beyond one truss. The floor is a reinforced concrete slab 5¼ ins. thick, and the sidewalk is also of reinforced concrete. The arrangement of the beams and of the concrete slab for the floor merits attention, as it is new and original. Between usual floor beams are longitudinal stringers spaced about 9 ft. center to center. On top of the stringers, extending entirely across the roadway, there are 8 ins. I beams spaced about 33 ins. apart. These roadway cross beams are bent to conform to the crown of the roadway, and the concrete slab rests immediately on top of them. The six

rails required for the two-gauge, double-track, street car tracks rest immediately upon the roadway cross floor beams and are fastened to them by standard Carnegie steel tie clips. The rails are 7 ins. high, so that there remains a space of 2 ins. in depth above the top of the concrete slabs to the top of the rail for the 2 ins. bitulithic surfacing which forms the pavement. To afford a rail heading which could be removed, if necessary, for access to the rails, or to the bonding, without injury to the roadway slab, the space about 5 ins. wide, on each side of each rail, is filled with concrete to the top of the rails, a flangeway being provided by forming this concrete. A drainage intake with down-spout is placed at intervals of fifty feet along each curb.



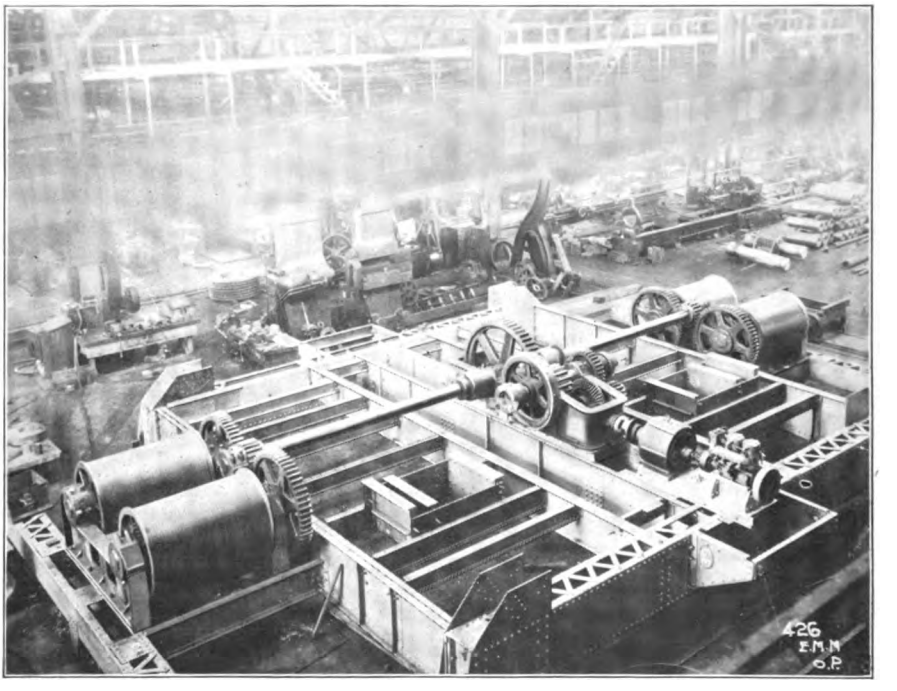
Engr. News.

This arrangement of floor has the advantage of providing a concrete slab longitudinal in the direction of travel, with comparatively short spans, and of making the supporting steel beams of very simple shop work. Owing to the lateral stiffness of the floor as constructed, the lower laterals of the spans are somewhat lighter than they would be for an open deck bridge.

Two fixed ends and two expansion ends of the spans are placed adjacent so as to reduce the number of expansion joints to a minimum. The expansion joints are made of usual type checkered plates supported by and sliding upon metal supports. The corresponding expansion joints for the rails between the spans consists of manganese-steel castings placed beside the webs of the rails, for which one side of the rail heads is planed off.

The towers supporting the lift span are of simple construction, riveted throughout, so arranged that the front columns of the towers support all the loads of the lift span and counterweights. The rear columns are bracing members. The lift span

is suspended from each of its four corners by sixteen plow steel wire ropes, 2 ins. diameter, which pass up and over cast steel sheaves 12 ft. in diameter, and are attached by a group of equalizing levers to concrete counterweights built around steel frames. These counterweights are of the same weight as the span, as nearly as possible exactly to balance it, so that the work to be done in operation consists of overcoming the friction and inertia, and of lifting the unbalanced portion of the ropes. The span is guided in its ascent and descent by cast steel jaws which engage upon tracks on the towers; at one end of the lift



MANUFACTURING THE STEEL.

The machinery for operating the lift span is here seen assembled complete in the shop where it was made, and placed on the structural members. This was done to insure accurate fitting of the parts. The simplicity of the operating machinery is apparent.

span these jaws guide both laterally and longitudinally, but at the other end the span is guided only laterally, thus allowing for expansion and contraction of the span and for slight variation in position of the towers. Operation is effected by means of operating ropes, of which there are two pairs at each corner of the span. The operating machinery, which is placed upon the span at its center, just above the roadway clearance, consists of

four spirally grooved drums connected by a train of gears to an electric motor. Each of these drums controls the operating ropes for one corner of the span; one pair of operating ropes, leading from the top of the drum, passes over a deflecting sheave at the corner of the span, thence downward, and connects near the bottom of the tower; and a corresponding pair of operating ropes leading from the bottom of the drum passes under a deflecting sheave at the corner of the span, thence upward, and connects near the top of the tower. All of the drums are similarly connected so that when they are operated in one direction the ropes leading to the tops of the towers are wound on the drums, and those leading to the bottoms of the towers are payed off, lifting the span by the force exerted upon the corner sheaves. The machinery for operation is thus exceedingly simple, consisting of one transverse shaft extending across the span; one pair of reduction gears in a frame inside of the house, and the back gears upon the motor. An indicator and limit switch is provided by which the current is automatically cut off and solenoid brakes applied to the motors at near the upper and near the lower limit of the run of the span. For ordinary operation there is a hand band-brake, which is equipped with a push button switch, so that when the span is under control the operator can hold off the emergency brake, and bring the span to rest in the control of the hand brake.

To provide for emergency operation, instead of the usual hand operating capstan, the span is equipped with a 12-horsepower gasoline engine connected through a speed reducer to the machinery, so that in case of failure of electric current the operator will be able to move the span at slow speed without having to seek outside assistance. There is a manually operated lock at each end of the span in connection with a centering device so that the span may be locked down. The solenoid brakes in connection with the down haul ropes also serve as a lock. Buss-bar trolleys are attached to one tower and a sliding contact shoe on the lift span supplies the current to the motors during operation. The operating ropes are attached at the tops of the towers to small drums with worm gear connections so that adjustment for the stretch of the operating ropes can readily be made. When the span is at its upper limit the counterweights are two feet above the floor level and a special arrangement of the trolley wires under the counterweight is made. This consists of swinging frames upon which the trolley wires are fastened, and which are pushed down by the counterweights and

returned to position through means of small counter-balances. The rail connections at the ends of the movable span are simple scarfed joints so that the span lifts away from the fixed rails and returns to them without any movable devices. The machinery is designed with great care and nicety. Gears and pinions which operate together are set in cast steel frames so that they could be adjusted and built complete in the shops; the adjustment of parts of the machinery in the field being reduced

THE COLUMBIA RIVER BRIDGE.
Near view of Vancouver end showing details of towers and of lift span. The moving span weighs about 1,200 tons and each counterweight about 600 tons. Can be lifted to 136 ft. above the tops of the piers. The towers extend to 190 ft. above the roadway.

to a minimum. All of the gears are cast steel with cut teeth. There is duplicate motor equipment with either motor of sufficient size to operate the bridge.

At the ends of the fixed spans adjacent to the movable span there are provided roadway gates of substantial design to make an effective barrier across the roadway, and these are connected to derailing switches in the street car tracks so that when the gate is closed across the roadway, the derail is thrown. These

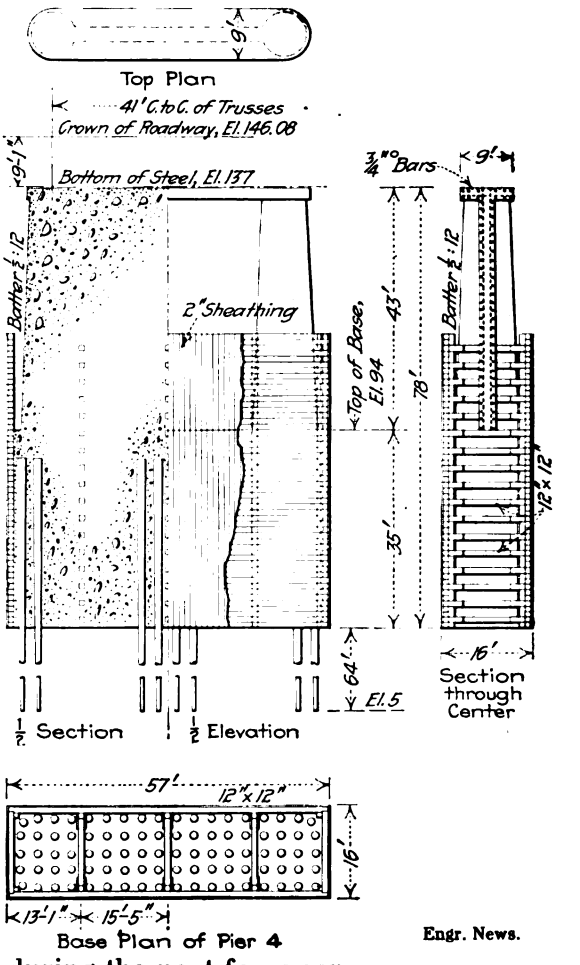
gates are manually operated and a small steel and concrete cabin is provided at each for the gate tender.

Several types of movable spans to provide the necessary channel openings for river navigation were considered, and the matter was narrowed to the selection of either a swing span or a vertical lift span. The Commissioners then desired to receive bids both upon the lift span and the swing span, and plans were prepared for the structure containing both types of movable span. The designs were made according to the same specifications and as nearly duplicate in character as possible.

Application was made to the War Department and tentative approval was received for either type of movable span, provided the swing span should have two channels, 200 ft. wide, or the lift span should provide one channel 250 ft. wide, with a vertical clearance of 150 ft. above normal high water. As has been stated, bids were received on both types of structure and it developed that the lowest bid for the bridge, including a lift span, was about $70,000 less than the lowest bid for the bridge, including a swing span. The lift span was thereupon adopted; not only for the advantage of the lower first cost, but also because, judging from the experiences of Multnomah County in operating bridges of both types, there will be continued advantages in lower cost of operation and maintenance. It is likewise more advantageous for river navigation, in that it provides a channel 250 ft. wide instead of 200 ft. wide, and the channel is not hampered by the long draw protection that would be necessary with a swing span. As the main channel is very close to the Vancouver shore, the necessary draw protection, about 500 ft. long, would have been a serious detriment to the dock frontage adjacent to the bridge.

The river at the site of the bridge is subject to a certain amount of scour, but inspection of the soundings taken for many years past did not disclose any indication of scour to extreme or unusual depths, although the river, both for some distance up stream and some three miles down stream, is deeper than at this site. The bases of the piers are of concrete enclosed by heavy timber cribs and extend down from 20 to 25 ft. below the river bed. The bases rest upon piles which extend to a depth about 110 ft. below low water. The piles used were about 120 ft. long in single sticks, about 10 ins. diameter at the tip and about 22 ins. at the butt. There is an average of about one pile to ten square feet area of base and in the average pier under the 265 ft. spans there are ninety piles.

The foundation piles are cut off a few feet below low water so that the upper ends of these piles are imbedded into the concrete of the bases of the piers from 15 to 20 ft. and the piles form a definite portion of the pier. It is evident that even though some unusual scour should, on some extraordinary occasion, extend below the bottom of the base, the pier would still be perfectly stable, owing to the great depth of penetration of the piles and to the rigidity of their upper support. Around each pier base there is an amount of heavy stone rip-rapping, which should be replenished, if necessary, during the next few years.



The shafts of the piers above the base are comprised of two cylindrical battered columns, one placed under each pair of shoes. These columns are joined by a vertical diaphragm and by the horizontal coping at the top, both of which are reinforced with steel. This design saves considerable weight which otherwise would require supporting piles and eliminates a large amount of concrete unnecessary for any structural purpose.

The occurrence of ice in the Columbia River in sheets or floes of large size is very rare, so that the concrete piers need no special protection of steel or stone facing.

The bridges over the sloughs consist of deck spans providing a roadway and floor of the same type and character as previously described, except that the girders are placed 23 ft. apart

transversely and a portion of the roadway and the sidewalk is carried on cantilever beams, and there are other minor details of differences, such as necessary trolley poles, etc. These spans rest on concrete piers supported by piles of the same general type as described, for the main river. The piles were sunk to about the same depths, but as the likelihood of scour is much less in the sloughs, the bases are not carried as far below the river bed.

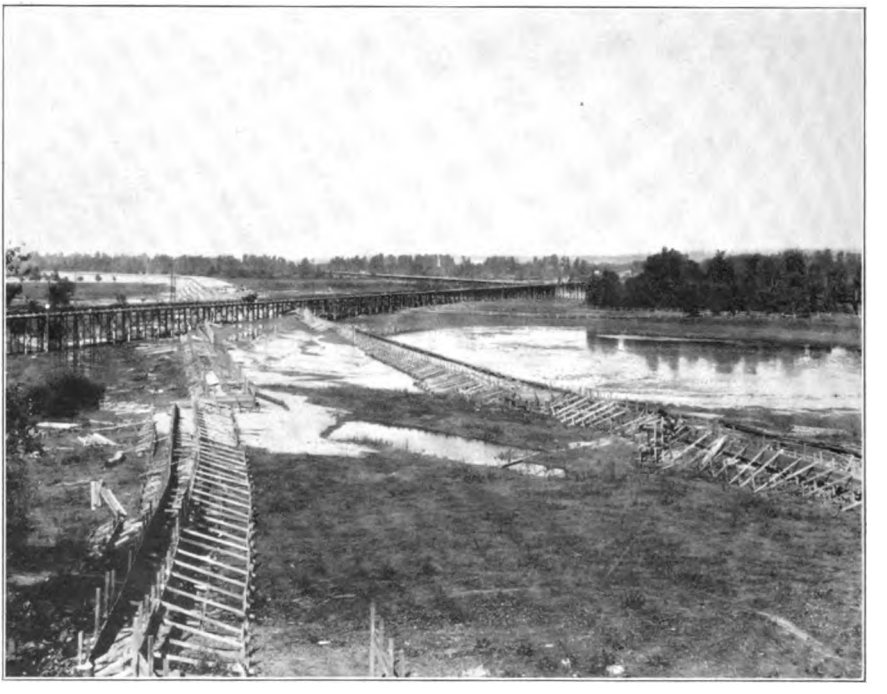
The bridge over the Oregon Slough consists of ten deck girder spans 100 ft. long, and one span 115 ft. long, making the total length 1,137 ft. 6 ins. At the present time there is no navigation in the Oregon Slough above the site of the bridge, but as there is possibility of navigation being developed above the site, it was necessary to provide for some type of movable span to furnish the necessary channel openings for vessels. Permission was secured from the War Department to build the structure with all fixed spans at the present time, with the provision that one span should be so arranged that at any time in the future when it may become necessary it can be converted into a movable span by providing towers at each end, and by equipping it with machinery, counterweights, etc., so that it may be operated as a vertical lift span. The 115 ft. span, above mentioned, is arranged for such possible use and will afford a channel 100 ft. wide. This provision and arrangement saves the Commission an expenditure at the present time of about $30,000 and permits a movable span to be provided when necessary without discarding any parts of the present structure and without interrupting traffic.

The bridge over the Columbia Slough consists of four deck girder spans of the same general type as described for the Oregon Slough, each 75 ft. long. After the first tentative approval of the plan for the Columbia Slough bridge was given by the engineers of the War Department, the status of this slough was changed so that there has become a remote possibility that it may at some time be considered navigable. It has therefore been agreed that should such development occur, one of these 75 ft. spans will be made to lift in the same manner as above described, providing a clear channel opening of 60 ft. in width.

The embankment over Hayden Island has a total length of about 1,480 ft., the embankment of the main approach to Union Avenue has a total length of about 10,500 ft., and the embankment in the secondary approach to Derby Street has a total length of about 5,800 ft. The embankment for the two approaches in Vancouver has a total length of about 500 ft.

The embankments across Hayden Island and in the main approach to Union Avenue are 42 ft. wide on top. The embankment of the secondary approach to Derby Street is 40 ft. wide on top and on the Vancouver approaches the widths conform to the widths of the streets occupied. The embankments average about 24 ft. in height and have side slopes of 2 horizontal to 1 vertical.

The upstream side of the Union Avenue embankment is protected to the elevation of 20 ft. above low water by concrete slabs laid on the slope of the finished fill. These slabs are 4 ins. thick, reinforced with wire mesh and in strips about 8 ft. wide, extending continuously up and down the slope. The overflow



EMBANKMENT CONSTRUCTION.

Union Avenue approach embankment. In the distance the completed embankment can be seen; near at hand the sand is just beginning to be deposited between the lowest bulkheads. The sand was pumped through 24-in. pipe, a maximum distance of 1¾ miles.

water, which at times of high water inundates most of the river valley, is largely back water and has no perceptible current, except that caused by its outflow from the river over the land as the river rises and its return flow to the river as the river falls. The time of greatest current with corresponding danger of erosion is at the time when the water is slightly above the height of the river bank, and occurs near the banks. For this reason

the concrete protection has been carried up to an elevation of 30 ft. above low water at the ends of the embankment where the high water of 1916 indicated erosion would occur, and at the buried piers has been carried up the full height of the embankment. The area on the slopes not covered by the slabs has been heavily fertilized and sown to grass, and it is expected that compact sod will be secured which will prevent local erosion. Great numbers of evergreen blackberries, a hardy indigenous shrub, have also been set out on the slopes to help in the prevention of erosion. The railing along each side of the embankment is of timber throughout of ample strength and rigidity for the prevention of serious accidents, as has already been proved.

The embankment across Hayden Island is more exposed than the other embankment and the Engineers of the War Department required that the slope protection extend entirely over both sides up to an elevation 30 ft. above low water or 5 ft. above normal high water. Owing to the exposed position of the Vancouver embankment, the slope protection there was similarly carried up to an elevation 30 ft. above low water.

On the Derby Street approach the high water of 1916 indicated that there was no serious danger of erosion from current except at the ends of the embankment. The Union Avenue approach serves as a protection to the major part of the upstream slope of this embankment, so that the concrete slope protection was provided only at its ends.

At each end of the main river bridge there are two entrance columns or pylons of concrete. These are of concrete rather than cut stone or marble because they more fitly represent the simple, straightforward construction of the bridge. They bear bronze tablets which give not only the names of the Commissioners, of the Engineers and of the Contractors, but also certain inscriptions which seemed to your Engineers to represent something of the thought and purpose and ideals of those responsible for the bridge. The inscription from Macaulay seems fitly to represent the purpose of the bridge; the inscription from Ruskin may fairly give the spirit of the builders, your Contractors and your Engineers; that from Carl Schurz is an appeal for remembrance of old ideals of patriotism and of service not unsymbolized by the bridge; and the last from the pen of Richard W. Montague and your Engineers is believed truly to indicate the origin and purpose of the whole endeavor.

By permission of the Commission, the Washington chapters of D. A. R. and S. A. R. have erected at the Vancouver end

of the bridge as a marker for the old Oregon Trail a simple stone drinking fountain which bears a bronze tablet symbolic of the Spirit of the Trail. The Oregon chapter of the same organization applied for and received similar permission for the erection of the trail marker at the Oregon end of the bridge.

Along both sides of the Union Avenue approach there have been planted roses and Scotch broom and there is similar planting about the entrance columns (seventeen hundred rose bushes and thirty-five hundred Scotch broom plants were set out). With a small amount of care and attention there will soon be added beauty to the substantial utility of the approach embankments.

LOADS FOR WHICH THE BRIDGE IS DESIGNED

The attention of your Commission is particularly called to the loads for which the steel portions of the structure were designed. In addition to the actual calculated dead load weight of all parts, and wind loads, provision was made for the following live, or moving, loads:

For the floor system and for girders:

On Street Car Tracks—Two 50-ton cars on each track.

On Roadways—12-ton motor truck, with special provisions for 24-ton machinery truck or loads per linear foot for each line of traffic varying with loaded length from 812 pounds for 25 feet to 735 pounds for 100 feet.

On Sidewalk—600 pounds per linear foot.

Impact allowance of 50 per cent is added to all except sidewalk loads.

For trusses:

On Street Car Tracks—Two 40-ton cars on each track.

On Roadways—Loads per linear foot for each line of traffic of about 500 pounds, but varying with the loaded length.

For impact allowances the following percentage of each load is added to it:

For roadway loading—$I = \frac{230}{NL + 300}$ but not greater than fifty per cent.

For street car loading—$I = \frac{180}{NL + 300}$ but not greater than fifty per cent.

Where I = percentage.
L = Length of load on bridge producing maximum stress.
N = Number of loaded tracks for street car loading, or number of lines of traffic for highway loading.

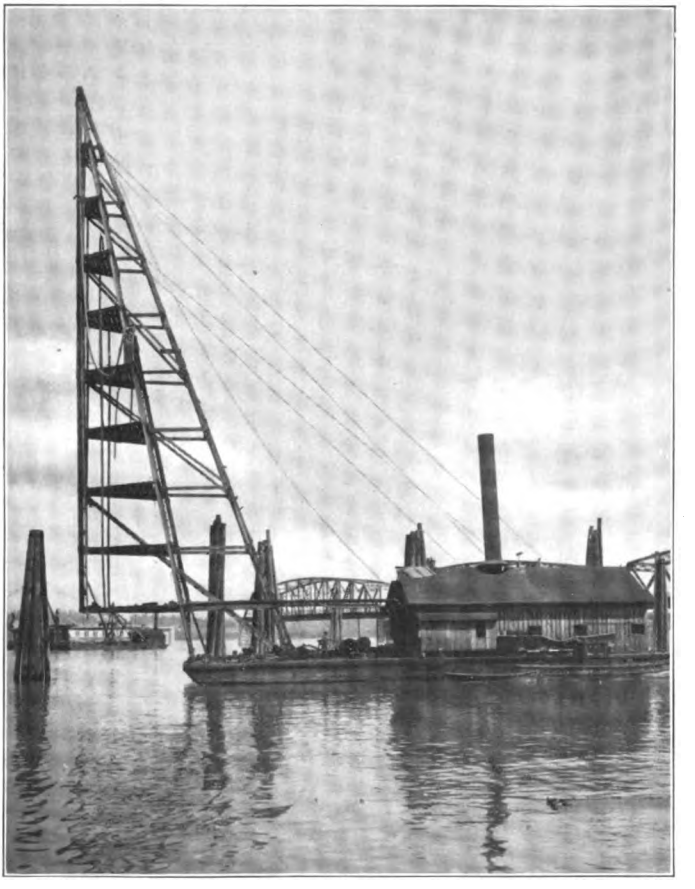
The above figures will convey to an engineer the permissible loads to be allowed to cross the bridge, but a more detailed statement may be of service to the Commission. The bridge was not designed for heavy locomotives or heavy railroad trains. Light trains, of course, can be operated across it with safety. The following limitation, which is included in your franchise to the only railway company now operating, sets out the maximum weights of locomotives, cars and trains which should be permitted to operate across the bridge. This should be your guide for granting permission for operation of trains or cars on the bridge:

"No car or locomotive of any character weighing in excess of 100,000 pounds gross load, or having any single axle load in excess of 25,000 pounds, shall be permitted on the structure; and no cars weighing over 80,000 pounds having a length of less than 20 ft. c. to c. of trucks shall be permitted on the structure. Two coupled locomotives or cars shall not weigh in excess of 180,000 pounds gross load; three coupled locomotives or cars shall weigh not in excess of 190,000 pounds gross load nor more than 1,600 pounds per lineal foot; four coupled cars or locomotives shall weigh not in excess of 210,000 pounds, nor more than 1,300 pounds per lineal foot; five coupled locomotives or cars shall weigh not in excess of 230,000 pounds, nor more than 1,200 pounds per lineal foot. Trains composed of more than five locomotives or cars, or both, shall weigh not more than 1,100 pounds per lineal foot."

The limitation on the roadway of a truck with load totaling 24 tons as given above needs no special explanation. The specifications for design employed have not been published and space does not permit their inclusion here, but if the Commission should at any time need information concerning unit stresses and details of design your Engineers will make a supplementary report to give that information.

SPECIAL FEATURES OF DESIGN

The marked economy of design came from a thorough study of local conditions and local possibilities for materials, and a fitting of the design and the plans to realize every possible advantage so offered. Possibly nowhere in the world are extremely long timber piles available at as low a price as at this bridge



BUILDING THE PIERS.

Pile-driver equipment used to sink the foundation piles for the piers. The leads are 122 ft. high above the water; the overhang is 22 ft. in front of barge. Equipped with two hoisting engines, two pumps, and 800-H.P. boiler.

site. Not only the river bed conditions already described, but this exceptional facility for securing such piles at reasonable cost was a considerable factor in determining upon the exact type of piers to be used. As has been described, the piles as delivered were single sticks from 120 ft. to 125 ft. long. The specifications described the special equipment, which would be

required for sinking these piles, an equipment which proved to be adequate and which accomplished the work, so that the piers as they stand are on piles which on the average extend into the river bed 25 ft. deeper than the bottoms of the piers of the railroad bridge adjacent. The conditions of the Columbia River and of the Oregon Slough were deemed to be particularly favorable to the erection of practically the entire bridge by building the spans on shore and floating them to position. The plans were made with this in view and the specifications indicated a preference for this method of construction, although the ordinary method of driving piles and building a temporary trestle on which to erect the steel work was not debarred. Different contractors bid upon different methods, but the bid taking advantage of the opportunity for floating the spans into place was $50,000 lower than the lowest bid for erecting on falsework. The exceptional opportunities for constructing the approaches by building permanent embankments by the hydraulic filling process also seemed to your Engineers to fix this as the proper design of structure, for there were abundant supplies of sand in Oregon Slough; cheap electric power, little difficulty with disposal of excess water, and cheap lumber for bulkheads; and the specifications so provided for dredging, although no limitation was made on the construction of the embankments by steam shovel and train haul, or other methods. Even though the length of embankment was beyond any precedent for this kind of work that your Engineers could find, the correctness of this decision was also verified when the bids for placing the work by hydraulic dredging were found to be less than two-thirds of the lowest bid contemplating train haul.

In the preparation of the plans, minute care was taken to secure every possible advantage which a duplication of items would afford. In the steel work there are, over the Columbia River, only two different truss spans, and the floor systems even of these are duplicated. Over the Oregon Slough there are likewise two patterns of longitudinal girders with one pattern of floor system, and over the Columbia Slough the girders are all duplicates and the floor system is the same as on the Oregon Slough. It was, therefore, possible for the structural shops to make only a few sets of patterns and to duplicate the parts many times, and this contributed very materially to the low price for manufactured steel. The same duplication was followed as far as possible in the design of the substructure so that the cofferdams and forms for the concrete could be moved from one pier to another and used repeatedly. The concrete floor was designed

so that the forms would be duplicate and interchangeable, and these were used repeatedly.

The details of every part were simplified with the most careful attention so as to make the manufacture and fabrication with as little complexity as possible, with the result that the steel work as delivered, both from the shops of the American Bridge Company and the Northwest Steel Company, was in excellent condition to be readily erected, properly fitting in every part. So accurately was the work of the American Bridge Company for the Columbia River trusses carried out that in driving the 17,000 field rivets in the first truss span there were found

MANUFACTURING THE STEEL.

View taken at Gary, Ill. All of the trusses were assembled at the shop, as shown lying on the ground here, all the holes for field rivets reamed, and the different members match marked so they could be erected in Vancouver in just the same positions. This insured perfect matching of holes for the field rivets.

only six rivet holes which had to be corrected in any way for the entrance of the rivet, and other spans were of the same general character. The same care of detailing and duplication of parts will be found in the machinery for operating the lift span and even in such details as the framing of timbers for the bases of the piers. The concrete floor slab was placed in just the position so that the reinforcing bars could be laid down on the steel cross beams and need no other support.

CONSTRUCTION METHODS AND EXPERIENCES

A complete description of the processes of construction will not be attempted, but three features which were of special interest deserve some description. These are (1) the method of building the piers and placing the long piles already described; (2) the erection of the superstructure metalwork by building the spans on shore complete and floating them to the piers; and (3) the construction of the approach embankments by hydraulic dredging.

(1) The plant and equipment supplied by the Pacific Bridge Company were unusual in certain respects and peculiarly adapted to the work in hand. Excavation was made by a dipper

BUILDING THE PIERS.

Removing a wooden cofferdam 16 ft. wide, 57 ft. long and 17 ft. high weighing 50 tons in one unit, after the lower portion of the concrete pier had been built inside it. This cofferdam was used for one pier after another.

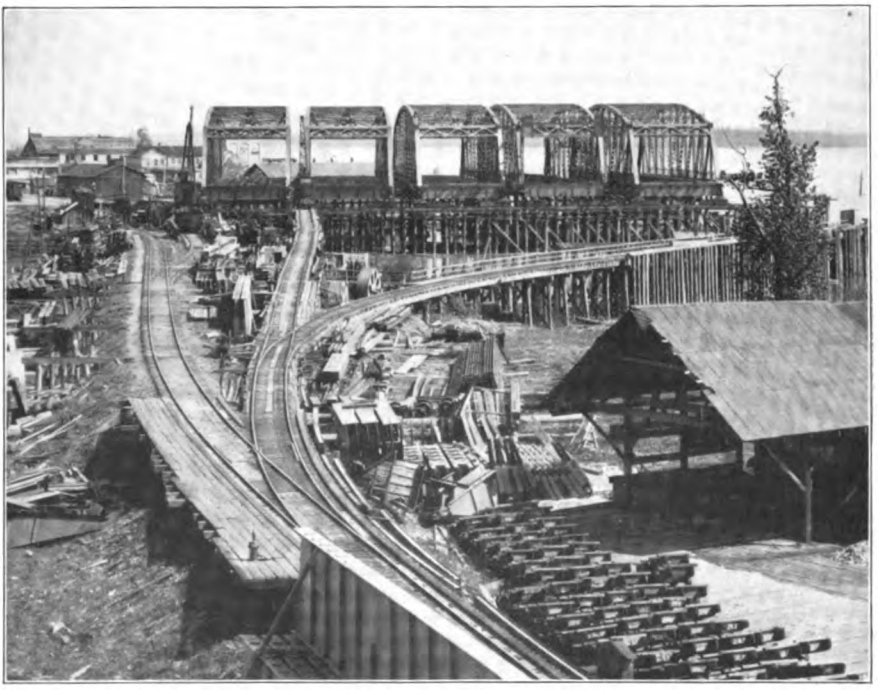
dredge of the shovel type having a 4 cubic yard bucket, an unusual equipment for such work. With this machine a hole was dredged into the river bed at the site of the pier to the full depth required and large enough to let the sides of the excavation take a natural slope. The timber crib enclosing the base of the pier was partly built on launching ways, floated to position and framed up to full height. A removable cofferdam in one section, used successively on different piers, was then picked up and placed on the crib, the crib sunk to the proper depth in

the excavation, and material of the river bed banked around outside to hold it in position. The foundation piles were then sunk by water jets inside of the crib.

For the sinking of these piles in the piers the second exceptional piece of equipment was provided, consisting of a pile driver of which the leads were 122 ft. high above the water, and built so as to overhang in front of the barge upon which it was supported about 22 ft. The lowest portion of this overhanging part was about 15 ft. above the water, so that this overhang made it possible to drive all of the piles in a pier from one side of the crib and at any stage of the water. This pile driver was mounted on a wooden scow 32 by 100 ft., 7 ft. deep. In addition to a No. 2 Vulcan Steam Hammer, the driver was equipped with two 4 ins. diameter jet pipes, 110 ft. long, connected by flexible hoses to the pumps. Water was supplied to the jets by two 12 ins. x 18 ins. x 10 ins. compound duplex pumps, each having a capacity of 1,000 gallons per minute. One four-drum hoisting engine and one two-drum hoisting engine supplied the power for handling the equipment and were all furnished steam from an 800-horsepower boiler. A pile would be set in place on the river bed and the jets discharging water with nozzle pressure of from 100 to 150 pounds per square inch played at its point. The jets thus bored a hole into which the pile slid down with the help of the steam hammer. It was an ordinary experience for one of these long piles to be sunk entirely to place within ten minutes after being placed in the leads and as many as 25 piles were driven in one day.

After the piles had been driven, the sand, gravel and other material washed up inside the crib by the driving was removed down to the bottom of the base and the base was filled by depositing concrete under water, through a tremie, up to within a couple of feet of the pile cut-off. When this concrete had thoroughly set the crib was pumped out, the piles sawed off and the remainder of the concrete for the base placed in the open. Wooden forms for the shafts of the piers of usual character were then built up to above water level and filled with concrete. The one-section cofferdam was then lifted off, to be used on a succeeding pier, and the remainder of the shaft forms built up and concreted. The river bed surrounding the pier could then be properly leveled up and adequate amounts of large rip-rap stone placed about the pier. This difficult foundation work was carried out by Mr. C. F. Swigert of Portland, under his personal direction.

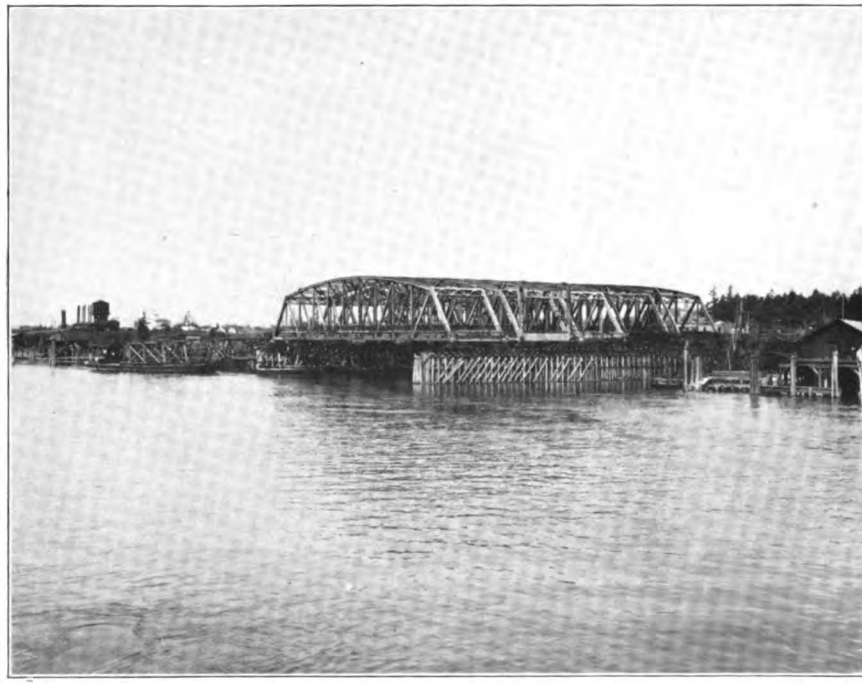
(2) For the erection of the superstructure metal work of the Columbia River Bridge the Contractor arranged a material and erection yard in Vancouver. Each span was erected parallel to the river on low falsework well back on the bank of the river. Launching ways were built at right angles to the erection falsework and extended from it out into the river into deep water at about the same height as the piers. These were 270 ft. long



ERECTING THE SUPERSTRUCTURE METALWORK.
The spans were erected back on shore, to the left, and as each was completed and riveted it was rolled out over the water on the ways. The steel storage yard, the yard tracks, the launching ways and five nearly completed spans are seen.

and each consisted of a heavy trestle with bents of piles spaced 5 ft. centers of five piles each with suitable caps. On each were four timber stringers 10 ins. by 20 ins. and on top of the stringers eight lines of 2½ ins. steel rails. Each span was erected by derrick cars operating on tracks running along each side of the falsework, and after all of the steel was in place and all of the rivets driven, the span was rolled out on the launching ways, using 22 rollers 1½ ins. diameter under each corner. Successive spans were thus built on the same falsework and rolled out on the same launching ways.

For moving the spans from the launching ways to the piers, four barges were used, on which falsework of timbers was built up to a proper height so that with a span on the barges the shoe of the span would be a few inches above the tops of the piers. When ready for moving, water was pumped into the scows supporting the falsework and they were floated underneath the span between the launching ways. Blocking was then placed between the falsework on the scows and the under part of the span so as to provide proper bearing, and the water pumped out of the scows, so lifting the span off the ways. The span floating on the barges was then towed out to position over the piers by



ERECTING THE SUPERSTRUCTURE METALWORK.
View of launching ways and spans ready to be transported as seen from the river. One of the barges for carrying the span may be seen to the left.

steamboats and tugs and water was pumped into the scows, lowering them and bringing the span to rest on the piers, and finally entirely releasing the scows, which were then taken back for another span.

The erection of the towers and other portions of the structure were by methods not unusual in steel erection, except that for the Oregon and Columbia Slough spans the material was all floated near to position on scows and erected from them. The

economies afforded by this method of erection have already been mentioned. The work was carried out under the personal direction of Mr. Guy Willard.

(3) The Tacoma Dredging Company moved its hydraulic dredge to the bridge site, installed pipes and pumped its first sand on June 9, 1915. By November 20th of the same year all of the embankment of the Union Avenue approach south of Oregon Slough had been placed, so that the placing of this material, which had a total net volume of 821,000 cubic yards, occupied 160 days, or a net average of about 5,000 cubic yards a day.

ERECTING THE SUPERSTRUCTURE METALWORK.
Transporting one of the spans from the launching ways on shore to its piers by floating. The span is 275 ft. long and weighs 500 tons. Its lowest part is about 35 ft. above the water. Four barges and two steamboats, besides tugs, were used for moving.

The material was excavated from the Oregon Slough by means of a suction dredge with a cutting head and was transported to place by being pumped through a line of pipe 24 ins. in diameter. The operation was by electric power and the main pump on the dredge was operated by two 500-horsepower motors. The pump was of capacity to give a discharge through the 24-inch pipe at a velocity of 12 to 15 feet per second. Operation continued 24 hours per day during the time specified and the dredge was actually running about 14 hours per day. For

periods of a few hours at a time the dredge pumped as much as 1,000 cubic yards per hour. There was, of course, a very considerable run-off of sand from the embankment, as well as a certain amount of fine material which flowed away with the waste water, and it is estimated that about 250,000 cubic yards more than the above net amount was transported. The discharge pipe line was extended to a length of about 5,500 ft., working from the dredge alone. For the greater distances a booster pump was installed in the line to give additional impetus. This pump was operated by a single 1,000-horsepower motor operating with considerable overload. The dredge and booster pump together transported through a maximum length of 9,000 ft. of pipe. Such long distance dredging into an embankment so comparatively narrow and high is believed to mark a record for work of this character. The pipe was of the ordinary riveted variety with slip joints made of 7 gauge material on the pontoons and of 10 gauge material elsewhere. It was moved about by teams and wagons.

The embankment was formed by the use of timber bulkheads. These were built of 6 by 8 ins. posts, about 10 ft. centers, supporting 2 by 12 ins. sheathing, surfaced both edges. The sides of the embankment were built up by these means in steps 8 ft. wide and 4 ft. high. The first bulkheads were placed upon the natural ground surface by driving in the 6 by 8 ins. posts with a hand maul and setting the lower plank into a small trench so that the bulkhead sheathing extended perhaps 8 to 12 ins. below the ordinary ground surface. When the sand had been filled in about the top of such first bulkheads, posts for succeeding bulkheads were set in place and the lower plank placed so that it extended about 12 ins. below the top of the first bulkhead below. These posts were tied back into the embankment by 2 by 6 ins. ties spiked on near the top of each post and extending back to a short post, in front of which were placed a few pieces of lagging to offer additional resistance. The pipe was laid to discharge into the middle of the embankment and was carried forward from the river, bringing the embankment up to the final grade and working away from the dredge. A framework of baffleboards was placed under the discharging end of the pipe, causing the water to spread out and spill over the ground below and run forward, distributing the different sizes of material as the velocity decreased. At some convenient low point there was provided an outflow down the side of the embankment, for which the steps of the embankment were paved with plank to prevent wash.

The methods of constructing the bulkheads and of the discharge arrangement are clearly shown by the accompanying photographs. After sections of the finished embankments became thoroughly drained as the work proceeded, the posts of the bulkheads were cut away and the planks removed and carried forward for repeated use. Parts of the posts and of the 2 by 6 ins. ties therefore remain in the embankment. The finishing of the slopes was done by hand with shovels, and the successive steps were so located that the upper corner of each step filled into the lower corner of the step below, to provide the proper slope. The actual pumping and transportation of the sand in

EMBANKMENT CONSTRUCTION.
Near view of Union Avenue approach embankment while depositing sand by pumping through 24-in. pipe. The wooden bulkheads were removed after pumping was finished, and the embankment dressed to smooth slopes.

the hands of these Contractors were the simplest parts of the work, and they found it economical to permit a very considerable wastage of material where such wastage saved in the construction of bulkheads.

This work was carried out under the personal direction of Mr. Edward Simpson of Tacoma, Vice-President of the Tacoma Dredging Company. The secondary approach to Derby Street

was constructed in a similar manner by an electrically operated suction dredge with 20-inch diameter pipe equipment. The maximum distance the material was carried was about 6,500 feet.

There were several slips or subsidences of the supporting land caused by placing the great weight of the embankment on it, but they were less in number or in aggregate amount than had been anticipated or suggested by the specifications. The subsidences of the land probably average less than one foot over the whole area of the embankments, but in three locations there were considerable subsidences, of which two instances required merely the reconstruction of some bulkheads and the placing of additional material. The third and most serious was a subsi-

EMBANKMENT CONSTRUCTION.
Looking toward Portland along the completed Union Avenue approach embankment. Width between fences 40 ft., pavement 30 ft. Height of embankment above surrounding ground about 25 ft.

dence combined with a slide at the south side of the Columbia Slough, which, although causing only comparatively small loss of embankment, destroyed the practically finished pier No. 27 in the slough. The weight of the wet sand embankment on the soft, oozy bottom of the slough and on the somewhat slippery bank was too much for the stability of the supporting material, and a part of the bank and the new sand just placed slid out into the slough, causing the damage to the substructure. The buried pier "F" on the land side of the slip was not disturbed by the move-

ment, and the similar construction on the opposite side of the slough had been completed and was standing satisfactorily. Additional embankment was placed for the portion which had subsided. The pier was then repaired and replaced with additional foundation piles and new concrete, and the entire construction was finished without further slides or disturbances.

The pavement construction was somewhat unusual. As the embankments were practically pure sand, ordinary methods of preparing the subgrade could not be followed. The specifications provided that the Contractor might either add clayey material to the sand surface in such amounts that the subgrade could be formed and rolled, or else merely shape up the sand to correct surface and then pour on enough water to pack the sand similar to a wet sand beach, hard enough to deposit and roll the stone, keeping the sand "continuously and thoroughly wet, hard, and firm until and during the placing of broken stone or concrete." The latter alternative was followed, but the broken stone base was rolled only lightly, as continued rolling caused the stone to work to the sides, and after the base had been shaped up by the light rolling a cushion coat of bitulithic paving mixture was applied and the whole thoroughly rolled. The placing of the bitulithic surfacing by standard methods followed immediately.

FRANCHISE TO PORTLAND RAILWAY, LIGHT & POWER COMPANY

The matter of Franchises for the operation of cars over the bridge came to the attention of your Commission soon after the construction of the bridge was started. At your meeting of April 30, 1915, you appointed an advisory committee on franchises, consisting of District Attorney Walter H. Evans of Multnomah County, Prosecuting Attorney James O. Blair of Clarke County, and Consulting Engineer Ernest E. Howard. Your Engineers prepared a tentative draft of a franchise which was submitted and critically passed on by the other members of the advisory committee, and after the submission of several reports by this advisory committee, with extended discussions by your Commission and representatives of the various traction companies interested in the tentative drafts submitted, your Commission on September 1, 1916, adopted a general form of fran-

chise, setting forth the general conditions under which special franchises to any company for the operation of cars over the Interstate Bridge would be granted. At this same meeting you granted the application of the Portland Railway, Light & Power Company for a franchise, and on September 20, 1916, adopted the draft of the franchise to be offered them, following the general conditions established. The acceptance of this franchise was delayed by the failure of the company to reach an agreement with the city of Vancouver relative to a franchise for certain necessary tracks in Vancouver. Early in December, 1916, it appeared that the reaching of such an agreement was quite unlikely, and as no other company was ready to act, and that, consequently, there would be no immediate car service across the bridge, your Commission on December 16, 1916, applied to the city of Vancouver for a franchise from the end of the bridge to the south line of Second Street on Washington Street, and on First Street and Main Street to the south line of Second Street. On January 2, 1917, your Commission received notice from the city of Vancouver, pledging the granting of this franchise, and ordered the placing of the necessary tracks. By this action you made possible an agreement between the city of Vancouver and the Portland Railway, Light & Power Company providing for the completion of the loop in Vancouver from Second and Main Streets to Second and Washington Streets by way of Third Street, and secured the acceptance by the Railway Company of the franchise over the bridge. The main provisions of this franchise are as follows:

(1) Date of expiration of franchise, December 31, 1921. At expiration of franchise, and failure of Commission and Company to agree as to its renewal, the Commission have the right to purchase such of the Company's tracks as are on the embankment forming a part of the structure. If the Commission elects not to purchase tracks, the Company has the right to remove same, repairing any damage done to the pavement by such removal:

(2) Franchise granted over only that portion of the structure between a point on Hayden Island about 200 feet south of the south end of the Columbia River Bridge and the end of the Commission's tracks at the south line of Second Street on Washington and Main Streets in Vancouver:

(3) The tracks south of the Columbia River Bridge, placed by the Company, are to be maintained by it, as are also the

tracks north of the Columbia River Bridge in Vancouver, which were placed by the Commission. The tracks on the Columbia River Bridge, owned by the Commission, are to be maintained by the Commission except as to extraordinary damages due to accidents, etc., when repairs are to be made by the Company:

(4) All overhead trolley construction to be placed and maintained by the Company:

(5) The Commission reserves the right to grant a franchise to other companies, such other companies to have the right to use the Portland Railway, Light & Power Company's tracks on the embankments through the purchase of an equal interest in them:

(6) The Company is to provide 30-minute service between the hours of 6 a. m. and 11:30 p. m.:

(7) The Company is to pay a toll of 25 cents per car and 3½ cents per passenger for passage one way:

(8) The most unusual feature of the franchise, as compared with the other franchises granted on the coast, is the provision that all income in excess of operating expenses and 6% interest on the actual investment in physical property under the franchise shall be divided 50% to the Company and 50% to the Commission. Included under the cost of operation shall be a charge for electric current used in the operation of cars, a fair rental of the cars used to pay for their maintenance and deterioration at a rate per car mile, a fair percentage for depreciation of the physical properties within the limits of this grant, and the amounts paid for tolls for cars and passengers on the bridge.

RIGHT OF WAY

The right of way owned outright aggregates in amount 34.7 acres. In addition to this ownership, the Commission holds easements covering privileges for slopes of embankments, etc., for maintaining roadways over other property, and also United States permits to build and maintain bridges over the Columbia River and over Oregon and Columbia Sloughs. As later set out, the total cost of this right of way was $25,449.63, which includes $13,814.41 paid out directly for lands and damages and $11,635.22 paid out for changing buildings and such work incidental

to right of way. This low total right of way cost is in part due to donations of land for the approaches.

Lands for rights of way were donated by:

The Peninsula Industrial Company; C. C. Colt, President.

The Riverton Land Company; R. V. Jones, President.

The Portland Railway, Light and Power Company; Franklin C. Griffiths, President.

The heirs of Fink and Stafford estate.

QUANTITIES

The following are the quantities in the various portions of the completed structure as calculated for the making of final payments to the contractors:

I.

COLUMBIA RIVER BRIDGE

(a) Substructure—Contract No. 7

Concrete in shafts and copings of all piers and buried piers above the tops of bases	5,354.6 cubic yards
Reinforcing metal in piers and buried piers	96,960 pounds
Mass in bases of piers from the bottom of base to top of base	15,806.7 cubic yards
Mass in bases of buried piers, from bottom of base to top of base	467.6 cubic yards
Piles below the bottoms of bases of piers and buried piers	78,826 lineal feet
Riprap stone deposited about piers	10,604 cubic yards

For temporary use during construction, the following:

Piles in dolphins for ferry landings for Portland Railway, Light and Power Company's ferry, and piles under runways for said ferry	19,672 lineal feet
Timber and lumber in temporary ferry landings and in runways for same	298,600 feet board measure

(b) Superstructure—Contracts Nos. 1, 2 and 11.

Metal in truss and girder spans	12,914,084 pounds
Metal in towers and counterweights	823,841 pounds
Street car rails, fastenings, etc	621,360 pounds
Machinery and wire ropes	356,698 pounds
Concrete in counterweights	589.2 cubic yards
Roadway slab and bitulithic paving between outer faces of curbs	15,316.6 square yards
Net area of sidewalk slab outside of outer face of curb	2,417.7 square yards
Concrete in railings and ornamental posts	84.3 cubic yards

II.

OREGON SLOUGH BRIDGE

Substructure—Contract No. 9

Concrete in shafts and copings of all piers and buried piers, above tops of bases	1,634.3 cubic yards
Reinforcing metal in piers and buried piers	25,742 pounds
Mass in bases of piers from the bottom of base to the top of base	2,356.1 cubic yards
Mass in bases of buried piers, from bottom of base to top of base	394.0 cubic yards
Piles below bottom of bases of all piers and buried piers	41,302 lineal feet
Riprap stone around piers	6,549.8 cubic yards

Superstructure—Contracts Nos. 5, 6 and 11

Metal work in girder spans	2,631,300 pounds
Street car rails, fastenings, etc	202,934 pounds
Roadway slab and bitulithic paving between outer faces of curbs	4,942.9 square yards
Net area of sidewalk slab outside of outer face of curb	656.2 square yards

III.

COLUMBIA SLOUGH BRIDGE

Superstructure—Contract No. 9

Concrete in shafts and copings of all piers and buried piers above tops of bases	838.1 cubic yards
Reinforcing metal in piers	11,784 pounds
Mass in bases of piers from bottom of base to top of base	704.9 cubic yards
Mass in bases of buried piers from bottom of base to top of base	493.3 cubic yards
Piles below bottom of bases of all piers and buried piers	13,366 lineal feet
Riprap stone around piers	1,500 cubic yards

Superstructure—Contracts Nos. 5, 6 and 11

Metal work in girder spans	600,440 pounds
Street car rails, fastenings, etc	55,120 pounds
Roadway slab and bitulithic paving between outer faces of curbs	1,352.7 square yards
Net area of sidewalk slab outside of outer face of curb	179.4 square yards

IV.

VANCOUVER APPROACHES—CONTRACTS NOS. 10 AND 12

Embankment	25,500	cubic yards
Slope protection concrete slabs	2,054.8	square yards
Rock fills at buried piers	618.3	cubic yards
Concrete in curbs	120.6	cubic yards
Excavation on Main street	848	cubic yards
Other excavation	682	cubic yards
Concrete base for paving	1,423	square yards
Broken stone base for paving	614	cubic yards
Bitulithic paving on concrete base	1,423	square yards
Bitulithic paving on broken stone base	2,444	square yards
Concrete sidewalks	1,032.2	square yards

V.

EMBANKMENT PORTION OF MAIN APPROACH TO UNION AVENUE

(Includes Hayden Island Embankment.)

CONTRACT NOS. 10 AND 12

Embankment	932,300	cubic yards
Excavation for drainage ditches	1,700	cubic yards
Rock fills at buried piers	3,624.4	cubic yards
Slope protection concrete slabs	38,942.2	square yards
Excavation for subgrade of paving	2,592	cubic yards
Broken stone base for paving	10,903	cubic yards
Broken stone in macadam paving	802	cubic yards
Bitulithic paving on broken stone base	41,337.4	square yards
Barrier fence	23,515	lineal feet
Concrete sidewalks	262.8	square yards
Broken stone in shoulder for paving	724	cubic yards
Excavation for shoulders	280	cubic yards

VI.

EMBANKMENT APPROACH TO DERBY STREET

CONTRACT NOS. 12 AND 13

Embankment	515,450	cubic yards
Excavation for drainage ditches	988	cubic yards
Rock fills	396.8	cubic yards
Slope protection concrete slabs	10,193.7	square yards
Excavation for subgrade of paving	568	cubic yards
Broken stone in macadam paving	4,556	cubic yards

STATEMENT OF COST OF CONSTRUCTION

The following figures are for the bridge and approaches complete ready for use. No costs of operation or maintenance since the bridge has been opened to traffic are included, and none of the income from toll receipts since the bridge has been in service is considered.

There is first given a tabulation of all expenditures according to construction contracts with the amounts paid by each County to each Contractor. (Table A.) There is then given a complete tabulation of the total cost separated into the principal units of the structure and into portions paid by each County. (Table B.) This table includes all the costs according to the construction contracts and also all the other features not covered by those contracts, such as right-of-way, engineering fees, etc., and gives the final total costs of the entire bridge and approaches.

There is then given a statement (Table C) of the financial condition of each County fund, again referring only to moneys having to do with original construction cost and not with either receipts or expenditures for maintenance and operation. It appears to us that Clarke County has not given full credit to this fund for interest or moneys held during construction, but may have diverted the interest to some other fund. If this interest were credited to the fund the balance on hand would be a little greater than that shown for Clarke County.

This final statement is followed by a detailed distribution assigning to each of the items as given in Table B the amounts from each of the contract numbers as given in Table A. The principal unit prices are also given.

TABLE A

TOTAL EXPENDITURES AS SHOWN BY THE ENGINEERS' ESTIMATES FOR EACH CONSTRUCTION CONTRACT

Contract Number	Contractor	Total	By Multnomah County	By Clarke County
1	U. S. Steel Products Co	$ 420,578.10	$ 252,346.86	$168,231.24
2	Porter Brothers	103,311.71	61,987.03	41,324.68
5	Northwest Steel Co	90,224.01	90,224.01	----------
6	Porter Brothers	18,881.75	18,881.75	----------
7	Pacific Bridge Co	331,875.66	199,125.40	132,750.26
9	Pacific Bridge Co	139,118.25	139,118.25	----------
10	Tacoma Dredging Co	179,244.82	172,988.18	6,256.64
11	Warren Construction Co	85,518.29	60,776.35	24,741.94
12	Warren Construction Co	98,111.92	87,889.23	10,222.69
13	Standard American Dredging Co	95,220.61	95,220.61	----------
L. S. 1	Pacific States Electric Co	3,252.32	2,784.59	467.73
L. S. 2	U. S. Steel Products Co	8,472.40	7,580.44	891.96
L. S. 3	Nelson and Brown	4,289.33	3,217.00	1,072.33
Special	Track Work on Vancouver Approach	7,139.99	----------	7,139.99
	Total	$1,585,239.16	$1,192,139.70	$393,099.46

TABLE B

TOTAL COST OF THE ENTIRE STRUCTURE AND THE COSTS OF THE PRINCIPAL SEPARATE PORTIONS OF THE STRUCTURE

	Total	Paid by Multnomah County	Paid by Clarke County
Columbia River Bridge	$ 891,005.45	$ 534,603.27	$356,402.18
Oregon Slough Bridge	196,944.47	196,944.47	----------
Columbia Slough Bridge	74,942.99	74,942.99	----------
Vaucouver Approaches	16,086.87	----------	16,086.87
Union Avenue Approach	251,220.26	251,220.26	----------
Derby Street Approach	104,877.76	104,877.76	----------
Lighting System	16,014.05	13,582.03	2,432.02
Ferry Landings	16,890.24	9,342.14	7,548.10
Tracks on Vaucouver Streets	7,139.99	----------	7,139.99
Right-of-Way	25,449.63	9,316.45	16,133.18
Fees to Engineers	80,000.00	57,142.84	22,857.16
Miscellaneous	2,984.61	2,522.97	461.64
	$1,683,556.32	$1,254,495.18	$429,061.14

TABLE C

CONSTRUCTION FUNDS—MULTNOMAH COUNTY

RECEIPTS

Sale of Bonds	$ 250,000.00	
Premium on Bonds	3,375.00	
Accrued Interest	6,250.00	
Sale of Bonds	1,000,000.00	
Premium on Bonds	31,900.00	
Accrued Interest	2,707.25	
		$1,294,232.25

DISBURSEMENTS

Coupon on Bonds	6,225.00	
Interest on Coupons	25.00	
Accrued Interest	2,707.65	
		8,957.65
Net Amount of Bond Issue		$1,285,274.60
Expenditures as given in Table B		1,254,495.18
Balance in Construction Fund		$ 30,779.42

CONSTRUCTION FUNDS—CLARKE COUNTY

RECEIPTS

Sale of Bonds	$ 500,000.00	
Accrued Interest and Premium	3,894.50	
Net Amount of Bond Issue		$ 503,894.50
Expenditures as given in Table B		429,061.14
Balance left from Construction		$ 74,833.36
Interest on Bonds paid from Construction Fund		49,375.00
Balance in Construction Fund		$ 25,458.36

TABLE D

Classification of expenditures given in Table A, to show cost of various portions of construction as shown by Table B.

The following are all amounts paid to Contractors on the Engineers' estimates:

	Total	Paid by Multnomah Co.	Paid by Clarke Co.
COLUMBIA RIVER BRIDGE:			
Contract No. 7 Substructure	$307,501.66		
Contract No. 1 Steel	419,992.24		
Contract No. 2 Erection	101,458.57		
Contract No. 11 Floor	61,854.84		
	$890,807.31	$534,484.39	$356,322.92
OREGON SLOUGH BRIDGE:			
Contract No. 9 Substructure	$ 89,895.10		
Contract No. 5 Steel	73,150.61		
Contract No. 6 Erection	15,319.45		
Contract No. 11 Floor	18,579.31		
	$196,944.47	All paid by Multnomah Co.	
COLUMBIA SLOUGH BRIDGE:			
Contract No. 9 Substructure	$ 49,223.15		
Contract No. 5 Steel	17,073.40		
Contract No. 6 Erection	3,562.30		
Contract No. 11 Floor	5,084.14		
	$ 74,942.99	All paid by Multnomah Co.	
VANCOUVER APPROACHES:			
Contract No. 10 Embankment	$ 6,256.64		
Contract No. 12 Paving	9,830.23		
	$ 16,086.87	All paid by Clarke Co.	
UNION AVENUE APPROACH (including Hayden Island construction):			
Contract No. 10 Embankment	$172,988.18		
Contract No. 12 Paving	78,232.08		
	$251,220.26	All paid by Multnomah Co.	
DERBY STREET APPROACH:			
Contract No. 13 Embankment	$ 95,220,61		
Contract No. 12 Paving	9,657.15		
	$104,877.76	All paid by Multnomah Co.	

	Total	Paid by Multnomah Co.	Paid by Clarke Co.
LIGHTING SYSTEM:			
Contract LS1	$ 3,252.32	$ 2,784.59	$ 467.73
Contract LS2	8,472.40	7,580.44	891.96
Contract LS3	4,289.33	3,217.00	1,072.33
	$ 16,016.05	$ 13,582.03	$ 2,432.02
FERRY LANDINGS, ETC.:			
Contract No. 7 Temporary Construction	$ 15,570.24	$ 9,342.14	$ 6,228.10
TRACKS ON VANCOUVER APPROACH:			
Contract—Special	$ 7,139.99	All paid by Clarke Co.	

RIGHT-OF-WAY:

The following items, which are here classified under Right-of-Way, include the amounts paid to Contractors for work such as raising and altering buildings, removing

car barn and street car property, etc. The amounts paid directly for right-of-way are given elsewhere:

	Total	Paid by Multnomah Co.	Paid by Clarke Co.
Contract No. 1	$ 585.86	$ 351.52	$ 234.34
Contract No. 2	1,853.14	1,111.88	741.26
Contract No. 7	8,803.76	5,282.26	3,521.50
Contract No. 12	392.46	---	392.46
	$ 11,635.22	$ 6,745.66	$ 4,889.56

TABLE E

Classification of items paid to others than the above Contractors and by the Commission directly—not through Engineers' estimates:

	By Multnomah County	By Clarke County
Columbia River Bridge (extra ticket houses)	$ 118.88	$ 79.26
Ferry Landings (land rent)	---	1,320.00
Right-of-Way (lands purchased and damages paid)	2,570.79	11,243.62
Fees to Engineers	57,142.84	22,857.16
Miscellaneous (includes advertisements, printing, attorneys' fees and other incidental expenses)	2,522.97	461.64
	$ 62,355.18	$ 35,961.68

TABLE F

UNIT PRICES

The principal unit prices paid to the Contractors are as follows:

COLUMBIA RIVER BRIDGE:	
Concrete in pier shafts	$ 9.00 per cubic yard
Mass in bases of piers	12.00 per cubic yard
Piles below bases of piers	.46 per lineal foot
Piles in ferry slips (Temporary use during construction)	.25 per lineal foot
Timber in ferry slips (Temporary use during construction)	30.00 per M. B. M.
Rip-rap around piers	2.05 per cubic yard (solid measurement)
Metal in truss and girder spans—	
Manufacture and delivery	2.59c per pound
Erection and painting	0.55c per pound
Metal in towers—	
Manufacture and delivery	3.43c per pound
Erection and painting	0.90c per pound
Electric railway rails, etc.—	
Manufacture and delivery	2.755c per pound
Erection	0.40c per pound
Machinery and ropes—	
Manufacture and delivery	10.00c per pound
Erection and painting	1.25c per pound
Concrete in counterweights	$14.00 per cubic yard
Concrete roadway slabs and bitulithic paving	3.48 per square yard
OREGON AND COLUMBIA SLOUGH BRIDGES:	
Concrete in pier shafts	$10.00 per cubic yard
Mass in bases of piers	16.00 per cubic yard
Piles below bases of piers	.35 per lineal foot
Rip-rap around piers	2.00 per cubic yard (solid measurement)
Metal in girder spans—	
Manufacture and delivery	2.55c per pound
Erection and painting	0.55c per pound

Electric railway rails—	
Manufacture and delivery	3.00c per pound
Erection	0.40c per pound
Concrete roadway slab and bitulithic paving	$3.18 per square yard
Concrete sidewalk slabs	2.10 per square yard
APPROACHES—In Vancouver:	
Embankment in place (net)	13.24c per cubic yard
Rock fills	$2.00 per cubic yard (solid measurement)
Concrete slope protection slabs	.80 per square yard
Curbs	11.00 per cubic yard
Sidewalks	.80 per square yard
Concrete paving base	.70 per square yard
Broken stone in paving base	1.39 per cubic yard (loose measurement)
Bitulithic paving on concrete base	1.15 per square yard
Bitulithic paving on broken stone base	1.17 per square yard
HAYDEN ISLAND AND UNION AVENUE APPROACH:	
Embankment in place	13.24c per cubic yard
Rock fills	$2.00 per cubic yard (loose measurement)
Concrete slope protection slabs	.80 per square yard
Broken stone in paving base	1.48 per cubic yard (loose measurement)
Bitulithic paving on broken stone base	1.17 per square yard
Barrier fence (timber)	.36 per lineal foot
Broken stone in shoulders	1.95 per cubic yard (loose measurement)
DERBY STREET APPROACH:	
Embankment in place	16.48c per cubic yard
Slope protection slabs	90.00c per square yard
Rock fills	$2.15 per cubic yard (solid measurement)
Broken stone in macadam pavement	1.95 per cubic yard (loose measurement)

MAINTENANCE

In the Columbia River Interstate Bridge and approaches you have a property which should be maintained in good condition. So maintained, there is hardly any limit to the life of the structure; but indifferently maintained, deterioration might come about with comparative rapidity.

(1) *Paint:*

The feature most subject to deterioration, aside from the pavement, is the steel superstructure work. To prevent rust the structure must be kept painted. For the purpose of future guidance in buying paint different makes of standard bridge paints were used—on different parts of the structure. You have thus a large, practical, comparative test of the different paints. As nearly as practicable, all paints were handled and applied uniformly, so that the paint which lasts longest, excepting accidents, should be considered the best paint for your location and conditions.

The paints used and the parts where they are used are as follows (Spans are numbered from Vancouver, the left span is No. 3):

COLUMBIA RIVER BRIDGE—Spans 1, 2, 3 and 4, and Towers:

Shop coat, Tockolith; first field coat, No. 1379 R. I. W. maroon; second field coat, No. 49 R. I. W. black. Made by Toch Brothers, 320 Fifth avenue, New York, N. Y.

COLUMBIA RIVER BRIDGE—Spans 5, 6, 7, 8 and 9:

Shop coat, red lead lute; first field coat, Metalkote brown; second field coat, Metalkote black. Made by Lowe Brothers, 451 East Third street, Dayton, Ohio.

COLUMBIA RIVER BRIDGE—Spans 10, 11, 14—The Oregon Slough bridge and the Columbia Slough bridge (except main girders):

Shop coat, Dutch Boy red lead in oil. Made by the National Lead Company, 111 Broadway, New York, N. Y. First field coat, Nobrac, brown; second field coat, Nobrac, black. Made by the Patterson-Sargent Company, 38th street and St. Clair avenue, Cleveland, Ohio.

COLUMBIA RIVER BRIDGE—Span 12:

Shop coat, Dutch Boy red lead in oil. Made by the National Lead Company. First field coat and second field coat, paint furnished by Dunn & Company of Portland, Ore.

COLUMBIA RIVER BRIDGE—Span 13:

Shop coat, Dutch Boy red lead in oil. Made by the National Lead Company. First field coat and second field coat, paint furnished by Rasmussen & Company of Portland, Ore.

COLUMBIA SLOUGH GIRDERS:

Shop coat, Tockolith. Made by Toch Brothers. First field coat, Nobrac, brown; second field coat, Nobrac, black. Made by the Patterson-Sargent Company.

We recommend that a thorough inspection of the steel structure to determine the condition of the paint be made once a year. Where such inspection discloses rusting of the metal, the metal should be thoroughly cleaned with scrapers and wire brushes and touched up with preferably the same kind of paint as was used for the original second field coat. This inspection should also be directed toward the discovery of accumulations of dirt and trash that will hold moisture and so hasten the destruction of the paint. All such accumulations should be removed.

(2) *Paving:*

In consideration of payment already made, the Warren Construction Company is obligated to maintain all bitulithic paving in repair for a period of five years. This will be till March 1, 1922. This maintenance contract also gives your Commission the option of requiring this company to undertake the maintenance of such paving south of the Columbia River bridge for a second period of five years, the exercise of such option binding your Commission to pay this company annually for such second five-year period 1½c per square yard of pavement covered by this contract.

(3) *Machinery:*

By section 31 of the Specifications, the United States Steel Products Company is required to replace any and every part of the machinery furnished by it which may prove defective within one year from the putting of the bridge into service, or prior to February 14, 1918. The machinery should receive regular care and inspection with special attention at all times to the proper lubrication of moving parts.

(4) *Wire Ropes:*

The attention of your Commission is particularly called to the maintenance of the wire ropes on the lift span. With proper attention these should not require renewal for many years, but it is essential that they be protected from rusting. Your Engineers recommend that in the summer of 1918, when the weather is warm, that the ropes be thoroughly cleaned of their present dressing and then treated with some first quality wire rope dressing made especially for ropes exposed to the elements and infrequently operated. Successive applications of dressing should be made as needed, so that rusting of the wires in the ropes may be entirely prevented. The ropes should be carefully inspected twice a year, early in the spring and late in the fall.

(5) *Substructure:*

The piers themselves are subject to practically no deterioration, although about ten years from this date it would be well to have them cleaned and painted with a wash of lime and cement. However, there has been placed a quantity of rip-rap, composed of stones varying in size from 1/3 cubic foot to 1½ cubic yards, around each pier. The object of this rip-rap is to prevent material scour of the river bed adjacent to the piers. Once a year for the next five or six years, after the high waters have passed, soundings should be made around the piers. If the rip-rap is found to be lower than about twelve feet above the elevation of the bottom of pier base for the Columbia River piers, or six feet above the bottom of pier base in the sloughs, some additional rip-rap of the same kind should be deposited. The elevations of bottoms of pier bases is shown on the drawings. In this connection, we desire to call to your attention that only a small amount of rip-rap has been placed at piers 11, 12 and 13, owing to the sand bar, whose top is above the top of these pier bases. In case the river channel should shift and this sand bar disappear, it will be necessary to place considerable rip-rap around these piers.

(6) *Embankments:*

Embankments, especially where resting on soft subsoils, and against which there may be overflow, are subject to deterioration or damage through several years and often do not finally consolidate for a long time. Your approach embankments have now passed through two seasons of high water of more than ordinary height with comparatively and actually small amount of damage. We believe this substantially perfect condition due to the manner in which the embankments were built, and we do not think you need be apprehensive of any very general or serious subsidence. For the protection of the slopes of embankments from erosion concrete slabs were constructed over parts of the slopes. In the main part these have held satisfactorily, but portions of the slabs on the Vancouver embankment washed down in the high water of 1917 and were replaced by rip-rap stone. The setting up of pronounced current with eddies might cause similar difficulties at the ends of the embankments on Hayden Island or at the slough crossings. However, the present cheaper construction may hold indefinitely and there is no need to place more stone now. For several years at times of extreme high water you should have embankments patrolled throughout, giving particular attention to the ends, so that cutting or washing may be stopped in incipient stages. These embankments are not unlike river levees and during their first five or six years should receive the same sort of patrolling during high waters. We consider it significant that the damage done by the 1917 high water was on a portion of embankment not constructed at the time of the previous high water, and that no damage was caused by the 1917 high water at the points where the chief damage was done in 1916.

Considerable expense has been entailed by the fertilizing and seeding of the slopes of the embankments, in order to provide a sod to prevent erosion and weathering of the slope. The results so far accomplished indicate that the securing of a compact sod is possible, but it may be necessary to refertilize the slopes and replant parts of the same from time to time for several years to secure satisfactory results. Attention should be given to this planting and also the roses and broom planted along the approach railings.

Evergreen blackberries were set out along the lower portions of the embankment slopes of the approach embankments with a view to developing in time a hedge sufficiently thick to keep cattle from climbing the sides of the embankments. Most of these bushes did not survive their first high water and it was concluded

wise not to replace them until after some sod had been formed over the sand. In the meantime, a light barbed wire fence was built along the bottom of the embankment to keep off the cattle. It is suggested that as the grass and other growths develop on slopes of embankments it will be well to set large numbers of evergreen blackberries, as at first intended, so that a hedge may develop. The cost of such planting will be small, but if carried out should make unnecessary the replacement of the present wire fence.

(7) *Power Supply:*

Soon after the bridge was put into service it appeared that the electric power supplied by the Portland Railway, Light and Power Company from their long feeder line from Portland did not hold up sufficiently in voltage to give prompt and speedy operation of the lift span. After investigating various possible sources of electric power supply, your Engineers recommended the installation of a rotary transformer at Vancouver so that adequate power might be there supplied, independent of the street car power line. This equipment has been ordered by your Commission and after it is installed there should be no further difficulty on account of low voltage.

TOLLS

Effective February 1, 1917, your Commission issued schedule of tolls as follows:

Item No.	SINGLE TRIP	Rates in cents except as shown
	PERSONS	
1.	Pedestrians, each (one person). See note	5
2.	One person on bicycle (including bicycle). See note	5
3.	Two persons on one bicycle (including bicycle.) See note	10
4.	Each person riding upon an animal (not including animal). See note	5
5.	Each person riding upon a vehicle not operating on a schedule, approved by the Commission. See note	5
6.	Each person riding upon a vehicle operated on a schedule, approved by the Commission, which schedule shall require regular operation of vehicles at least once an hour for twelve (12) consecutive hours per day. See note	4
7.	Each person riding upon a vehicle operated on a schedule of service approved by the Commission, which schedule shall require regular operation of vehicles at least every forty (40) minutes for seventeen (17) consecutive hours per day. See note	3½
	Note—Children 7 years of age and over, full fare; under 7 years of age, free.	
	LIVE STOCK AND ANIMALS	
8.	One animal driven, led or ridden, of cattle, goats, hogs, horses, mules and sheep	5
9.	For drove of animals including cattle, goats, hogs, horses, mules and sheep on foot, ten head and under, each	5
10.	For each head, over ten head, in one lot	2

SELF-PROPELLED VEHICLES

11.	Motorcycles	5
12.	Passenger vehicles having seats for two persons (one-seat runabouts)	10
13.	Passenger vehicles having seats for not more than eight persons	15
14.	Passenger vehicles and cars having seats for more than eight persons	25
15.	Trucks or motor delivery wagons commonly called of one-half ton capacity	10
16.	Trucks not over one ton capacity	15
17.	Trucks over one ton, but not over two ton capacity	25
18.	Trucks over two ton capacity	50
19.	Wood sawing machines	15
20.	Self-propelled vehicles moving under their own power, not otherwise specified, including farm engines and road rollers	50
21.	Trailers drawn by self-propelled vehicles, for each trailer	15
22.	Freight cars running on railway tracks, either self-propelled or drawn	75
23.	Electric locomotives	$2.50

The rates of items No. 11 to No. 23, inclusive, are exclusive of passengers, operators, drivers or persons in charge, except that for passenger vehicles or cars capable of seating more than twenty-five passengers, two persons shall be carried free, provided they are engaged in operating the same.

VEHICLES DRAWN BY ANIMALS

24.	One vehicle drawn by one animal	10
25.	One vehicle drawn by two animals	15
26.	One vehicle drawn by three animals	25
27.	One vehicle drawn by four animals	35
28.	One vehicle drawn by six animals	50
29.	Each additional vehicle in tow	10
30.	Each additional animal	5

INCOME AND TRAFFIC

The income from tolls for the first ten months is given in the following table:

1917	Electric Railway Tolls	Vehicle Tolls	Total	Daily Average
February (14 days)	$ 1,702.76	$ 2,019.84	$ 3,722.60	$265.90
March	3,518.91	4,472.74	7,991.65	257.79
April	5,011.13	6,218.11	11,229.24	374.30
May	4,605.58	7,066.75	11,672.33	376.53
June	4,930.97	9,308.60	14,239.57	474.65
July	5,925.84	11,426.87	17,352.71	559.76
August	.....	.....	17,650.91	569.38
Sepetmber	.....	.....	15,479.57	515.98
October	.....	.....	15,511.26	500.36
November	5,550.63	8,583.64	14,134.27	471.14
Total (289 days)	.....	.....	$128,984.11	$446.31

The average daily receipts have been $446.31, and the highest $837, which was taken in on July 4th. The interest on moneys on hand brings up the total average daily receipts to $448.53. The income, therefore, is surpassing the most sanguine expectations. The total daily average operating and maintenance expense over the same period has been about $80. The bridge is therefore more than self-supporting; and, if present conditions continue, it will pay for itself in a few years. The counties have actually

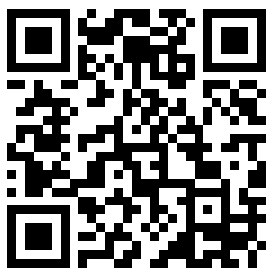
acquired this valuable property by making use of their credit and wholly without adding to the burden of general taxation.

Counts of the traffic are taken periodically and in time will afford interesting data of the traffic development. For instance, even at the present time more than ten times as many self-propelled vehicles as horse-drawn vehicles cross the bridge. It is notable also how much freight now goes by motor truck which did not go by that means when the river had to be crossed by ferry.

LIFT SPAN MOVEMENTS

The number of operations per month of the lift span varies with the state of the river and the boat traffic. In an average month there are from 200 to 225 openings. The average time which traffic is delayed by each opening is from two to two and one-half minutes; many times the delay is only one and one-half minutes. The total time the lift span is open and traffic delayed is about ten hours per month, which includes night operations. The navigation, therefore, does not cause much more delay to the roadway traffic than a busy street intersection.

THE COLUMBIA RIVER BRIDGE.
Parade of band and U. S. troops, crossing the Columbia river, opening the bridge to public travel.



DOCUMENTS GOVERNING THE CONSTRUCTION OF A BRIDGE

INCLUDING

A Reprint of the Specifications, Proposal, Contract and Bond of the Columbia River Interstate Bridge, a Description of the Structure, and a Discussion of the Function of Specifications.

BY

E. E. HOWARD
M. Am. Soc. C. E.
M. Am. Soc. M. E.

OF

HARRINGTON, HOWARD AND ASH
Consulting Engineers
Kansas City, Mo.

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PREFACE

These Specifications with forms for Proposal, Contract and Bond are reprinted in the present book with the thought that the general clauses of each—if not the special clauses—may be of value in suggesting satisfactory substance and arrangement for like documents. Engineers usually prepare for their particular needs special specifications or clauses covering specific materials or processes, or find them readily available; but the engineer principally occupied with other work sometimes is at a loss to find a guide which shows such various special items grouped together, in satisfactory balance, with comprehensive general clauses.

Owing to the pressure under which the work of most engineers is done, all specifications tend, through periods of years, to become principally a collection of accretions to an original draft, with inconsistencies and useless matter, so that full abandonment of the old and complete rewriting are at times essential. The specifications and accompanying papers for the Columbia River Interstate Bridge now under construction from Portland, Oregon, to Vancouver, Washington, are wholly new and are not collections of parts of any former specifications. They cannot, however, be considered experimental or untried for they are written after many years of active practice in the preparation of specifications for bridges and in the direction of construction under them. Of necessity, they incorporate the thoughts and ideas of many of those specifications and the results of the experiences inseparable from their administration. They attempt to retain the desirable and satisfactory features of former specifications; to eliminate unfair and useless provisions; to make clear ideas that may have been obscure; and to crystallize the judgments and conclusions from former experiences. They aim to be specific without being narrow; to be definite without being captious; to require work of the highest character but without arbitrary idiosyncrasies of detail of questionable value expensive to the owner and hopelessly irritating to the contractor; and to provide that the owner shall get what he pays for and shall pay for what he gets. They intend to provide for the best commercial products in every feature. They do not accept the indifferent commercial article or workmanship but neither do they require workmanship or materials beyond the reach of good first-class commercial practice.

While in the main the language and expression are the author's, the specifications are the joint work of Mr. Harrington, Mr. Ash, and the author. The general outline was selected and each clause, in turn, was prepared, discussed, debated over, altered and rewritten, with some deliberation, to meet all contingencies such discussion could suggest. The specifications are the product, therefore, of a variety of experiences; of technical opinions and engineering judgments reached only after years of practice; and of the combined and correlated views of the members of the firm. They

also reflect the views of many engineers who have been associated with the firm both in the design and in the execution of work, of manufacturers, of contractors, of public and private attorneys, the published experiences and opinions of engineers in no way related to the firm, and the general summaries of engineering reading and study. It is not expected that they will meet the approval of every engineer, indeed, the three engineers jointly responsible for them are not agreed upon every point, nor are they thought to be immutable—there are, in fact, several variations in this reprint from the original draft. But these specifications have been subjected to the most stringent and, in some cases, unfriendly analysis, and to the critical study of manufacturers and contractors, and even of ambitious political critics, without material valid fault being found, and with very few misunderstandings of import and meaning. The bids made under them were, for all classes of work covered, closely competitive within narrow ranges, showing that the various bidders interpreted the requirements very much alike. The prices bid were as low or lower than those paid for any similar work in the same general locality, the work so far completed is of high grade, and the owners are assuredly receiving their money's worth. It is a pleasure to add that all of the eight contractors have reported that they are making profits.

In order clearly to appreciate the meaning of specifications, it is necessary to understand the theories upon which they are founded, the relations of persons involved, the methods of conducting the business they contemplate, and to know thoroughly the structure to be built. All of these facts, as well as the design, and all or most of the plans are—or should be—in the possession of the writer of specifications when he begins his work. There will be given a brief discussion of the function of specifications and a general description of the bridge.

Perhaps it would be well to amplify the oft-repeated caution that specifications "must be interpreted upon the broad grounds of professional intelligence and common sense" by pointing out that not common sense alone is needed for interpretation, but common sense supported by mature engineering experience and judgment. Many clauses in specifications cannot be plucked out and interpreted as a unit, but must be taken in conjunction with other clauses, and sometimes with the plans in order to be clearly understood.

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THE FUNCTION OF SPECIFICATIONS

The word "Specifications" as employed by engineers, is not, unfortunately, confined to one meaning, but must be accompanied by modifying words to convey a definite idea. There may be for any structure, Specifications for Design, a stipulation of loads to be carried, or purposes to be accomplished, with a statement of working stresses and methods of proportioning various parts; and distinctly apart, Specifications for Construction, a recital of the qualities required in materials and of methods and processes for combining them. Under the usual handling of construction work, Specifications for Construction are always a part of a contract, while Specifications for Design often are not. Only Specifications for Construction are herein discussed; the questions of design are predetermined and are not the concern of a contractor carrying out the work. The Specifications and Contract, therefore, belong together; separate documents are common only because of custom and convenience. All might be included in one document, or certain clauses of each, with all propriety, included under the other.

A contract between two persons, to be just to each, must represent a "meeting of minds." There is difference of opinion and of desire, but each must have the same understanding, the same interpretation, the same intention, which the words of the contract should reasonably express; otherwise there is no agreement. But words are often ambiguous, points of view at variance, and even in very simple matters a meeting of but two minds is not always easily expressed. As the subject in hand becomes more complex, occasions for honest misunderstanding multiply indefinitely. The witty suggestion has been made that the confusion of tongues at the time of the construction of the Tower of Babel probably was occasioned by bickerings and misunderstandings over the meaning of the plans and specifications. With a small number of persons involved and with personal contact, it is possible to incorporate into a contract the views of each; but when many different persons are affected, the form of contract becomes a statement of the desires of one person or group with which other persons are invited to concur. Specifications form a part of this sort of contract.

Various methods have been used to accomplish the construction of engineering structures from that most simple, where the designer builds with his own hands and perhaps varies his plans as the work proceeds, to those required for extensive works, where the ideas of the designer are carried out by others often not at all in personal contact with him. The most frequently followed and the method most approved today involves a purchaser, an individual or corporation wishing to purchase the structure; an engineer employed by the purchaser to provide the design, plans, specifications, supervision and inspection; and contractors, who undertake to furnish labor, materials, plant, tools and equipment, and to perform the work. Many contractors are engineers, but as herein used the word "engineer" refers

to the purchaser's representative. These specifications contemplate such a relationship of the parties involved: the engineer to make the plans and to see that they are carried out, the contractor to perform the work, the purchaser to receive and to pay.

The purchaser selects his engineer as he would select his lawyer or his doctor and, if he is wise, calls his engineer as he should call his other professional advisers—at the beginning of the case. The duties and functions of the engineer are varied and comprehensive; a full recital will not be attempted. This whole discussion of specifications may be considered to bear upon the engineer's relation to the work. Although employed by the purchaser, and although supplying the technical and trade knowledge to guide the purchaser in dealing with contractors and others having more specialized information than the purchaser, the engineer is more than an advocate. He really stands between the purchaser and the contractor as a judge and referee. His broad and even arbitrary powers require an attitude of judicial independence. Sometimes it is more difficult to compel the purchaser to deal fairly by the contractor than to compel the contractor to deal fairly by the purchaser.

After studying the needs and the possibilities, the engineer designs the structure and he prepares plans and specifications to describe the structure he has designed and to provide for its construction. Taken together these should be complete and should so complement each other that the contractor may know in advance just what is to be required of him. Usually there are additional working drawings made by the contractor to enable him to accomplish the work; but these are drawings of method, not of design.

There was a time when contractors prepared many designs, but on all except small and inconsequential work, that condition has passed. The large contractors, such, for instance, as the American Bridge Company, decline under most conditions to submit designs. The contractor usually is not equipped to give deliberate study to the design problems. He is almost sure to over-emphasize the features having to do with construction, sometimes at the expense of the permanent service of the structure. However conscientious, it is doubtful whether he can so free his mind from the construction problem as to secure the design wholly most efficient instead of the design most profitable in construction. The aesthetic and artistic feeling, with a value recognized today by the most utilitarian of clients, does not thrive where financial considerations are always uppermost. The wise purchaser, therefore, calls upon his engineer to make the design and plans most suited to his needs, and then makes arrangements with contractors to carry out the plans, just as he calls upon his doctor for a prescription and then goes to a druggist to have that prescription filled. And he views patent engineering nostrums as he views patent medicine nostrums.

The plans and specifications are the engineer's description of what his client, the purchaser, wants to buy. It is assumed that the purchaser, or the engineer for him, knows what he wants, and that the contractor is to be paid for what he does and the risks he takes. This description should make clear the relations of the parties, the work to be done, the times in which it must be done, and the method of payment. It should be so complete that the contractor may know in advance everything that is to be required of him so he can include a charge for every item in his bid. It is not

the explicit specifications with imperative requirements that is unfair to the contractor, but the indefinite requirement which may be overlooked and not charged for in a bid. Both plans and specifications are needed for this description. Many features are described much more readily by the plans than by specifications; with very complete plans the specifications may be simplified, with meagre plans the specifications must needs be in greater detail. Generally speaking, the features covered by the one are best omitted from the other. Details which will affect various workmen who work directly from the drawings but are not likely to read the specifications—such as machine shop notes, etc.—are given on the plans. Sometimes it is convenient to find on the drawings notations covered by the specifications; as, for instance, the proportions of certain concrete, but no advantage is gained from describing at length the general features easily grasped from the drawings. The contractor's working drawings, or drawings of method, always give such specification details. A clause concerning drawings sometimes criticized, often misunderstood, makes the contractor responsible for the engineer's drawings as to dimensions and correlation of various parts. This does not mean responsibility for adequacy as to design. It means simply that the contractor intends to furnish a complete usable structure and he undertakes to see that the various parts of it fit properly together.

The engineer should show by the plans and specifications not only the structure as it is to be when completed, but, except where the work is so usual that methods are well known and standardized, he should indicate at least one method by which it can be constructed. The designing engineer who asks for bids on unusual structures for which he suggests no processes of construction, makes himself liable, except in very special cases, to be criticized for laziness if not incompetency. The engineer who does not know how his structure is to be built, and who could not at need secure the plant, equipment, employ the labor and proceed to construct the work, cannot fully and properly serve his client.

But more is required of contractors than merely the assistance of their organizations in buying materials and employing men. The able contractor is expert in construction methods. At the present time everyone pays the same prices for materials and labor, and one contractor can do work for lower cost than another only because of the intelligence, the brains, the ability he puts into the scheming and management. In order to secure to his client the full advantage of every construction method, the engineer should not limit the contractor to the one method, but whenever possible, should leave open the manner of accomplishing the results. Each contractor may then offer the scheme for carrying out the work he thinks most suitable. If specifications fix both results and processes, if they restrict the contractor within too narrow limits in methods of accomplishing the work, the contractor becomes merely an employer of labor and the advantages of his special abilities are lost. Not his abilities of design, which are likely to be limited, but his abilities of construction, which are likely to be very expert.

The engineer should have sufficiently broad grasp of the general problem, and sufficient practical knowledge and experience both to originate and to pass intelligently upon construction ideas. The mere novelty of some contractor's scheme for accomplishing work should not condemn it; the engineer should not be afraid of the new, but he must guard his client against the im-

practicable imaginings of inventive dreamers almost sure to result in disaster, delays and expense. Contractors are increasingly becoming specialists along narrow lines. The busy contractor is principally occupied with his own work and his own method of doing it. The advantage which the experienced engineer has in coming into intimate contact with the work of many contractors, and of learning something from the methods of each, can hardly fail to give him a breadth of vision, and a general intelligent grasp of construction problems of every character, and of the methods and processes most suitable in any given case.

These specifications call definite attention to methods of construction by requiring contractors to submit with their bids a definite written program for handling the work, and a list of plant and machinery proposed for use. This assures, before work begins, an exchange of views and discussion of construction methods between engineer and contractor. Instead of a cursory, off-hand examination of the problem, which postpones the solution of each difficulty until its occurrence, the contractor finds some real, definite preparatory study necessary.

It is made clear also that these statements, with a citation of works of similar character and quantity performed by the contractor making a bid, are to be considered in part a measure of his ability. Bidding by contractors wholly incompetent is likely to be at once discouarged and eliminated. Contractors, perhaps competent but of limited experience, may fairly understand that their time in preparing bids, even if low, may be wasted unless their previous work has been of sufficiently important character to warrant their employment. The engineer and the purchaser have the very real advantage of a definite basis of comparison of different bidders. When bids are close, or for any other reason the assigning of work becomes practically a matter of selecting a contractor, it is not always easy to make a just choice. The statements cannot fail to give indication of the abilities of the bidders; every bidder has fair opportunity to make the best possible presentation; and all bidders must be treated alike.

There are instances where the engineer will find it necessary to devise and describe the method by which the work should be done, or the equipment to be used, as well as specify the results to be secured. At other times, methods of construction seemingly most suitable may well be suggested. The specifying of equipment must be done circumspectly. The same plant and machinery will produce widely different results when handled in different ways. One crew of men will do better work than another, or will succeed with the same equipment and under the same conditions where the other crew will fail. Adequate plant alone will not assure success.

The specification for jetting piles for the Columbia river piers may be cited as an example of required specific method and equipment. The work is unusual in scope, the practicability of sinking such piles to such depths was questioned by so many contractors, that it was desirable to let bidders know just what would be accepted as adequate plant. A specification merely of "efficient jetting equipment" would not have meant to some contractors the 2,000-gallons-per-minute pump capacity which the engineers deemed necessary. The use of piles 125 feet long in these piers may also be cited as an example of the facility with which the engineer may take advantage in his design of special local conditions and materials. To serve the same purpose,

structures in various locations may be radically different. There are but few locations where such piles can be supplied at low price and the advantage of their use secured.

Suggestive, but not restrictive, methods of construction may be found in these specifications, in the recommendations for erection of spans by floating, and for construction of embankments by dredging. In both instances the work has been carried out by the methods proposed, although bids were submitted which contemplated erecting the steel upon falsework and building the embankments by steam shovel and train haul. Although such suggestions may not be followed, they help to lay before bidders all possible information; they generally represent the conclusions from perhaps months of study of problems which bidders often have but brief time to consider; and while they need not necessarily prevail against the opinion of the construction specialists, are generally worthy of his respect.

Complete description to every inclusive detail, even with plans and specifications together, is not possible; there must still remain that standard of measure "satisfactory to the engineer." As far as practicable, attempt is made to eliminate such characterization, but it must be an important factor. Even if every contingency could be forseen and described, the writing of every degree of possible variation into specifications would make them bulky and wordy beyond reasonable use. This standard or measure is as much for the protection of the contractor as of the purchaser. In public work, particularly, cases are not unknown where the purchaser, especially if represented by some office holder with a ready ear for every curbstone-engineer-taxpayer, will try to insist upon the literal wording of some clause without the tempering of any engineering judgment.

Private and semi-private corporations are often with execration termed "soulless corporations," but everyone who has had broad experience with public and private contracts will agree that generally the most "soulless" are the public corporations or political units. Cities, counties, even States, and the federal Government are much more likely to be without honor or compassion in exacting the last drop of blood, in insisting upon a strained technical phrasing of some clause, than are the great private corporations. A contractor is fortunate in such cases to have in control a courageous and just "engineer's opinion."

The specifications provide that the contractor shall carry out any instructions the engineer may give, but there is no provision that the engineer must give any detailed instructions. The plans and specifications should be so complete that a competent contractor can proceed without any further instructions. Sometimes the engineer is called upon for instructions which it is not wise for him to give. He may sacrifice some of his client's rights through detailed instructions lightly given.

There will be found among the clauses defining the purchaser's rights some which place in the hands of the engineers very full authority over the contractor, even to the seizure and use of his plant and other property, and to removing him personally from the work. Contractors sometimes complain of these clauses, but it should be remembered that, after all, it is the purchaser's money; it is at the purchaser's option that the money is spent, and his rights should be fully guarded not only over what he has paid but over what he is to pay. These clauses are of advantage to the legitimate con-

tractor, who really has nothing to fear from them, because they have a strong tendency to keep away the illegitimate trouble-makers who bring disrepute upon the whole contracting business. The standard of business morals today among men engaged in construction work, usually classified under contractors, is as high or higher than in most other businesses. But there are some men, as there are in other occupations, who must be guarded against. On public work, the lowest bid is sometimes considered the only necessary qualification for a contractor and such clauses serve to protect other bidders, as well as the purchaser, from the misdirected efforts of inexperienced optimists.

"Caveat emptor" may be good law, but it is not good engineering ethics; it may be respectable in business, but it is not the attitude of the better contractors of today. This does not mean the abandonment of inspection; the better contractors all welcome inspection, for in a large organization it is not easy to make the action of every workman and employee reflect the employer's attitude. At times the slighting of work that would cause a failure is a greater damage and misfortune to the contractor than to the owner.

But, notwithstanding the general confidence with which the engineer may be regarded, there should be some method provided so that either the purchaser or the contractor, in case he may consider himself unfairly treated, may require a reconsideration or rehearing of the engineer's opinions. Specifications that attempt to close all possibility of appeal against a decision that may be unjust are obviously unfair. Only an engineer who is afraid of his opinions and his ability to justify them, or who is temperamentally biased or prejudiced will object to any proper inquiry or reconsideration. These specifications allow for the arbitration of the engineer's decisions by an arrangement that each party will select one arbitrator, and, if these cannot agree, a third arbitrator is to be appointed by some disinterested person. The engineer's position really is made stronger by such a provision.

Although arbitration seems to be the best method that can be offered for adjusting differences, it rarely turns out to be wholly satisfactory. Many arbitrators consider themselves advocates of the claims of the party who chose them and are not true, independent arbitrators. This merely transfers the quarrel to men sometimes more stubborn than the principals, and leaves to the third arbitrator the whole onus of decision. Other arbitrators take the view that arbitration requires always and means only compromise.

If the parties to the contract, as well as the engineer, keep in mind the just principle that the purchaser should pay for what he gets, and the contractor should be paid for what he furnishes, there are likely to be few requests for arbitration. Usually an engineer needs only be honest and reasonable to have his decisions accepted without dispute, although they may be grumbled at. There are a few almost professional contracting litigants, but most business men are too busy to want to get into court with quarrels. In some States the conclusions of an agreed arbitration are final and binding, but usually after an arbitration either party may still take the matter to the courts. So with any reasonable decision, most contractors and most purchasers are willing to take what they consider a little the worst of a decision rather than either to arbitrate or to commence lawsuits.

At times questions arise involving mistakes made by engineers. It can be said without conceit that, principally because of the almost universal cus-

tom of checking and verifying designs, drawings, and estimates, such mistakes are not common. But in spite of utmost care they sometimes occur. The contractor should not be held responsible for the engineer's mistakes. The engineer's relation to the purchaser is one of professional service. It is not one of financial responsibility. If the engineer makes a mistake it is the client's loss. If a doctor makes a mistake, it is the patient's loss. The druggist is not held responsible for the doctor's mistake. If a lawyer makes a mistake it is the client's loss. If he has been diligent, if he has used his best judgment—even though that judgment be poor—the client cannot recover damages for the failure. If the doctor, the lawyer, or, most particularly, the engineer makes mistakes, he cannot continue practice, for his clients leave him. The client must take the chances of such mistakes.

But the contractor's relation to the purchaser is not one of professional service. It is one of the bargain and sale. It does contain financial responsibility. The purchaser wants to buy, the contractor to sell. The purchaser has had written down what he wants to buy. It may be materials, labor, service, legal responsibility, personal responsibility, risk, or even a guarantee of service, or a combination of them all. No hardship is done a contractor in asking him to bid an amount of money for each or for all. And after he has entered into a bargain he should expect to carry it through.

The specifications and contract must be within the law, but cannot assume to take the place of the law. Nearly always there will be found special laws and statutes governing the contract and the contractural relations. It is not desirable in the specifications to quote extensively, statutes, laws, or ordinances. A general reference is usually preferable. All existing laws and ordinances are, in legal phraseology, so read into the contract as though they were cited at length. Something is almost sure to be omitted when a full recital is attempted. The specification which purports to quote laws or statutes fully, misleads if any one item is omitted. It is not the repetition in the specifications of laws or ordinances that makes it necessary for the contractor to comform to them, nor does the omission relieve him of the legal penalty for illegal acts. But, as a courtesy, attention may be called to special or unusual legal provisions, so that a bidder may not neglect to secure proper legal advice.

The purchaser receives; he is to pay. He is to pay the engineer for his services, he is to pay the contractor for the work done and for the risks taken. The purchaser knows that something for nothing is worth about what it costs, and does not expect to have plans furnished free, nor to have the work done for less than cost, nor to have the contractor work without a profit. There have been purchasers as there have been engineers, who seemed to rejoice when a contractor had been caught in some snare and made to perform work without compensation, but fortunately both are becoming rare. As the purchaser pays, he may, of course, at his option, have the engineer specify any superlative degree of work, and it is no hardship to ask a contractor to bid upon such work. If purchaser and engineer both should err in judgment, no harm is done the contractor provided he is paid for the work done and for the risks taken. The specifications are at fault if the purchaser has to pay money without return. The inclusion of drastic requirements which will not, and perhaps cannot, be fulfilled, will waste money, for the careful bidder must assume that time and efforts will be demanded for experiments to attain the impossible. Capricious and eccentric

ideas have no place in specifications, where for every dollar spent there must be value received.

The most equable method of payment for this class of work is payment by unit prices. The contractor is paid for what he supplies, the purchaser pays for what he gets. If a lump sum is paid for a completed work, the sensible bidder must add an amount for overrun contingencies, or the familiar so-called "extras," so that when quantities under-run, the purchaser pays for something he does not receive—or at least he pays for a risk he had much better assume himself. With unit prices, too, it is easy to make minor changes without having to reconsider the whole contract, as at times becomes necessary with a lump sum bid. In such negotiations the contractor has an advantage over the purchaser, for often it is not possible for the purchaser to do other than permit the contractor to make his charges, which of necessity deprives the purchaser of competition on the particular item.

Bidders should be advised as to the approximate times at which payments will be made. The excessively, and even ignorantly, cautious provision that no payments will be made until the entire work is completed, only reacts against the purchaser. It makes the contractor's financing more expensive, which, of course, must add to the purchaser's cost, and tends to restrict competition. No useful service is gained when there is a performance bond and when the work is properly looked after by the engineer. Monthly partial payments with a reserve of about ten per cent are ordinarily found to be very satisfactory.

Even with unit price contracts, wide variations from estimated quantities may be unfair to the contractor. In case quantities are reduced, the percentage of the almost constant general overhead cost upon each unit will increase and the contractor not be fully compensated. It is also possible, but somewhat less probable, that an over-run of quantities may damage a contractor. In a case where piers were carried several feet deeper than the plans contemplated, it was evident that the excavation and, in less degree, other operations for the lower portion cost more per unit than for the upper portions. But as long as the costs do not become higher than the amounts paid, the contractor still makes his gross profit on the whole job although his profit per unit on the additional work may be less than on other units. The specifications provide what seems a reasonable adjustment for such conditions.

In order, therefore, to secure the advantages of reasonable competition and to compare the ideas and abilities of various contractors, the specifications provide for the award of the work upon unit price payments, after competitive bidding. For ease of comparison the bids must be uniform in make-up. If every bidder is permitted to name conditions there can be no reasonable or true comparison, as there is no standard of measure. There should be given a form for bids ready to be filled in and signed. This form is a proposal to do what the purchaser wants done. By its wording, attention of bidders can be directed to some of the more special requirements to be met. When brief, this can be included in the body of the specifications, or, as in this case, made an appendage.

Bidders should be put to as little expense as practicable in the preparation of their bids. They bid more or less as a favor to the purchaser. There is certain to be some expense, but it is not fair to require extensive expendi-

tures unless payment is provided. For this reason the engineers *give* approximate quantities divided into several units under each class of work. Frequently bidders will make for themselves additional sub-divisions, but the greater work is saved, and they are not exposed to the ever-present fear, when quantity estimates are made in a hurry, of making some large blunder in quantities by forgetting to multiply by two, or some such easy error.

With the bids, there is required a certified check as a warrant of good faith. Bidding bonds are sometimes used, and while of possible value, are evidently not as certain and quick as the certified check. At rare intervals it is very important to hold some bidder to his proposal, and quick action often is essential. If the purchaser trusts to a bidding bond, he has the privilege of arguing the matter over with the bonding company, perhaps in the courts. If the purchaser has the actual money in hand, he can act immediately and then rest secure while the bidder makes the argument to get it back. A certified check is a bird in the hand.

There are two other documents appended to the specifications, the advertisement and the performance bond. The requirements or advertisements are well known and are often fixed by statute. The performance bond is not only to protect the purchaser's property, but also is a safeguard for the contractor. It is wise for the purchaser to provide the form for the bond. The forms supplied by bonding companies are naturally prepared from their own point of view, and sometimes apparently to give the purchaser principally the right to go to law if he doesn't like what the company may decide. Of course, any bond may require a law suit to enforce payment, but it is just as well that the bonds be written from the point of view of the purchaser.

In order to describe by plans and specifications a structure to be built, the engineer must himself first know thoroughly what the structure is to be, and how in one or several ways it may be constructed. If any part is obscure in the mind of the engineer, he cannot avoid obscurity in that part of his specifications. But more is required than merely knowledge of the given structure. For the ultimate development of the best specifications, it is essential that the writer should have personal contact with the work done under them. Lack of personal experience with the daily difficulties of construction is responsible for many of the extreme and unfair provisions sometimes encountered. The actual daily experience, the personal observation of the working effect of the various clauses, is certain to temper and improve successive specifications. This does not mean any lowering of standard—it may mean making some requirements more rigid, but also making them more definite, plain and workable.

The writer of specifications should consider them from various points of view. He should assume that he is spending his own money; the thought of having to pay for idiosyncrasy of idea is likely to make the requirement more conservative; the thought of possible large money loss is likely to insure the insertion of clauses safeguarding the work and controlling the possible unscrupulous contractor. He should assume that he is bidding on the work; the feeling of perplexity of one attempting to master in a few days not only the essentials, but also the details, of a large work will make for clear and definite expression; the attitude of the non-technical bidder, perhaps eminently able to perform the work economically, will make for simplicity of

language; the position of the large manufacturer who debates whether the one job is sufficiently important to alter usual standards and methods will tend toward the use and acceptance of commercial products where at all suitable. He should assume that he is both a successful and an unsuccessful bidder, and he will try to write his clauses so that from either view they may appear fair and equable. And throughout he should assume and maintain his attitude of judicial independence, weighing fairly between bidders, contractors and purchaser, and dealing with justness toward all.

While attempt at literary polish may be out of place in specification writing, gross disregard of grammatical form cannot be excused. At times uncouth construction, sentences without verbs, and mistakes of carelessness and ignorance are only amusing; at other times they are most serious; always they detract from clearness and are apt to cause some apprehension as to the general intelligence, if not the technical ability, of the writer. Frank, straightforward language with simple expression should be used. The specifications must clearly and definitely show the meaning of the designer so that a reader can have but one understanding, and every reader must have the same understanding. No one can go far in the interpretation of the specifications and in the direction of work under them without a realization that even very simple sentences can, with all honesty, be taken to have some other than the intended meaning by the alteration of one word, or even by punctuation or emphasis. The most exact language is capable of various interpretations, and loose language is the cause of most contentions over construction matters. Specifications cannot be too carefully prepared, even from a grammatical standpoint.

The mechanical make-up of the specifications results from numerous experiments and gradual alteration. The size, 8½ by 11 inches, ordinary letter size, will fit any ordinary letter file, and folded once vertically, will fit into the pocket. The specifications are bound in book fashion so as to be easily read. The paper is of tough, bond stock to stand rough usage in the field, and to give good surface for signatures and notations. The small type is used to save space; the bold face to make it distinctive and readable. The specifications, proposal, contract and bond are bound together so that one or another of the component parts of the whole cannot be lost or mislaid. In looking over the records of past transactions of individuals, of private corporations, and particularly of public corporations, the advantage of such a combination will be evident. It very often develops that some document essential to a full understanding has been abstracted for an immediate pressing purpose and not carefully returned to its original position. There is also the advantage of the contractor having before him all the papers to which he is asked to subscribe. Under present day organization of business, the sales department is sometimes far removed from the legal department, so that even with the exact form of contract shown in advance, the legal department will often bring forward objections which the sales department has overlooked, and if the contract form does not accompany the specifications, objections to any form later submitted will be certain and vociferous.

These, then, are some of the ideas with which the engineers approached the preparation of these specifications. Should space permit, the occasion for nearly every clause and provision could be illustrated from actual experiences. Whether some special features are over-emphasized at the expense of others must be a matter of opinion. Perhaps some are carried to

extremes; perhaps less detail in certain cases would have sufficed. *It is very* difficult not to linger upon the items most of interest at the particular moment. But they do represent an attempt to describe clearly and definitely what is to be required; to provide that the purchaser should pay for what he receives and should receive what he pays for; to enable contractors to bid intelligently and at as small expense as practicable; to fix the results to be secured but to leave as open as possible the methods and processes of construction, and to afford a basis of fair and just dealing between purchaser and contractors.

A DESCRIPTION OF THE BRIDGE

The following description will give the reader about the information that bidders could secure by examination of all the plans, and by study of the site and of other local conditions not covered by the specifications.

The Interstate Bridge over the Columbia River and Approaches will extend across the Columbia River Valley from the city limits of Vancouver, Washington, to the city limits of Portland, Oregon; a distance of about three and one-quarter miles, and will include about five thousand linear feet of steel bridge structure and twelve thousand feet of embankment, with a secondary approach on the Oregon side for which, at the present time, an embankment about six thousand feet long will be built. The Bridge and Approaches will provide a roadway for street traffic and for street cars, and over the steel structures, will provide a sidewalk. The Columbia River at times of extra high water covers the entire three-mile width of the valley and extends from the city limits of Vancouver to the city limits of Portland. The Vancouver end of the Bridge is located at the intersection of Washington Street and First Street at a point which is said to be within a few yards of the location of the old river dock of the Hudson Bay Company's Post at Vancouver, the first important settlement on the river. The Bridge and Approaches form one of the most important and most expensive sections of the series of highways included under the "Pacific Highway," which, in the course of a short time will make possible highway travel on the Pacific coast from Burrard Inlet to the Gulf of California.

The construction of the Bridge is the result of a popular movement originated by the Commercial Club of Vancouver, Washington, and the Commercial Club of Portland, Oregon, carried forward with great enthusiasm, gaining wide support both from the people of Washington and Oregon. An attempt was made to have the structure built by the two States, but when this was not successful, the two Counties, including the above two communities provided funds by issuing general County bonds, after an election voting them almost unanimously. Multnomah County issued $1,250,000 of bonds and Clarke County issued $500,000 of bonds. The Bridge is being constructed under the direction of the Columbia River Interstate Bridge Commission, comprising the Commissioners of Clarke County, Washington, and the Commissioners of Multnomah County, Oregon, with the Governor of Oregon acting as a Commissioner of Multnomah County for certain purposes.

The Columbia River at the site is 3,500 ft. wide, with a maximum depth of 30 ft. at extreme low water and with variation from extreme low to extreme high water of 33 ft. The water rises each spring to about 20 ft., and about once in four years to about 25 ft. So far as known it has reached 33 ft. only once. The bed of the river consists of sand with small amounts of gravel, extending to great depths. At the north shore very compact cemented gravel is found a few feet below the surface dropping off to 100 ft. below at

about 700 ft. from the north shore. Over the remainder of the river only sand with some gravel was found to depths of more than 100 ft.

The Oregon Slough forms an important secondary channel particularly for flood conditions. It is about 1,000 ft. wide and 25 ft. deep, and is separated from the main river by an island about 1,500 ft. wide. The U. S. Government has built a dike some distance above the bridge site and the island to divert practically all of the low water flow down the main channel of the river, the top of the dike being about 6 ft. above low water. The bed of this slough is principally sand.

The Columbia Slough provides some drainage near the Oregon side of the valley, is about 300 ft. wide and 20 ft. deep at low water. The bottom is of clay and sand; hard and compact gravel is found about 80 ft. below low water.

The average elevation of the ground across the river valley is from 12 to 15 ft. above low water, so that much of it is inundated at every high-water period.

The roadway is 38 ft. wide between curbs, or 41 ft. between trusses, with steel hand rails where required. Over the steel spans there is one sidewalk 5 ft. wide. Double track street-car tracks for both standard and narrow gages are placed in the middle of the roadway, spaced 10 ft. 8½ in. c. to c. The vertical clearance in trusses is 21.5 ft. The entire roadway, both on the bridges and embankment, is to be paved with hard surface pavement. A lighting system will be provided.

For entrance features there are placed at each end of the main river bridge on the embankments portions of concrete hand rails terminating in ornamental concrete columns about 22 ft. high, supporting lamps, and forming the beginning of the steel hand rails.

The live loads for which the structure is designed are as follows:

For the floor system and for girders:

On Street Car Tracks—2 50-ton cars on each track.

On Roadways—12-ton motor truck, with special provisions for 24-ton machinery truck or loads per linear foot for each line of traffic varying with loaded length from 812 pounds for 25 ft. to 735 pounds for 100 ft.

On sidewalk—600 pounds per linear foot.

For impact allowance 50 per cent is added to all except sidewalk loads.

For trussses:

On Street Car Tracks—2 40-ton cars on each track.

On Roadways—Loads per linear foot for each line of traffic of about 500 pounds but varying with the loaded length.

For impact allowances the following percentage of each load is added to it.

For roadway loading—$I = \frac{230}{NL+300}$ but not greater than fifty per cent.

For street car loading—$I = \frac{180}{NL+30}$ but not greater than fifty per cent.

Where I = percentage.

L = length of load on bridge producing maximum stress.

N = number of loaded tracks for street car loading, or number of lines of traffic for highway loading.

The specifications for design employed have not been published, and the working stresses used in the design are not exactly in accord with any general specification now extant, but space does not permit inclusion here.

The Bridge over the Columbia River consists of a series of through riveted truss spans with curved top chords; three spans 275 ft. long and ten spans 265 ft. long together with a small deck girder span at the Vancouver end, making a total length of 2,531 ft. 5⅞ in. between end shoes. Provision for navigation on the river is made by a vertical lift span. The central of the three 275 ft. spans is arranged to lift between towers on the other two, so as to afford a channel 250 ft. wide at right angles to the current of the river and 150 ft. high above ordinary high water.

For the through spans the trusses are spaced 41 ft. c. to c. with the roadway between and the sidewalk beyond one truss. The floor is a reinforced-concrete slab 5¼ in. thick, and the sidewalk is also of reinforced concrete. The arrangement of the beams and of the concrete slab for the floor merits attention, as it is new and original. Between usual floor beams are longitudinal stringers spaced about 9 ft. center to center. On top of the stringers, extending entirely across the roadway, there are 8 in. I beams spaced about 33 in. apart. These roadway cross beams are bent to conform to the crown of the roadway, and the concrete slab rests immediately on top of them. The six rails required for the two-gage, double-track, street-car tracks rest immediately upon the roadway cross floor beams and are fastened to them by standard Carnegie Steel Tie clips. The rails are 7 in. high, so that there remains a space of 2 in. in depth above the top of the concrete slabs to the top of the rail for the 2 in. special bituminous concrete surfacing (Bitulithic) which forms the pavement. To afford a rail heading which could be removed, if necessary, for access to the rails, or to the bonding, without injury to the roadway slab, the space about 5 in. wide, on each side of each rail, is filled with concrete to the top of the rails, a flangeway being provided by forming this concrete.

A drainage intake with down-spot is placed at intervals of fifty feet along each curb.

This arrangement of floor has the advantage of providing a concrete slab longitudinal in the direction of travel, with comparatively short spans, and of making the supporting steel beams of very simple shop work. It is expected that the cross floor-beams will be formed to their curve by shimming up the hot-beds to a proper curve, so that the beams may form while cooling. Owing to the lateral stiffness of the floor as constructed, the lower laterals of the spans are somewhat lighter than they would be for an open deck bridge.

Two fixed ends and two expansion ends of the spans are placed adjacent so as to reduce the number of expansion joints to a minimum. The expansion joints are made by the usual type checkered plates supported by and sliding upon metal supports. The corresponding expansion joints for the rails between the spans consist of manganese-steel castings placed beside the webs of the rails, for which one side of the rail heads is planed off.

The towers supporting the lift span are of simple construction, riveted throughout, so arranged that the front columns of the towers support all the loads of the lift span and counterweights. The rear columns are bracing members. The lift span is suspended from each of its four corners by sixteen plow steel wire ropes, 2 in. diameter, which pass up and over cast steel sheaves 12 ft. in diameter, and are attached by a group of equalizing levers to concrete counterweights built around a steel frame. These counterweights are of the same weight as the span, as nearly as possible exactly to balance it, so that the work to be done in operation consists of overcoming the friction and inertia, and of lifting the unbalanced portion of the ropes. The span is guided in its ascent and descent by cast steel jaws which engage upon tracks on the towers. At one end of the lift span these jaws guide both laterally and longitudinally, but at the other end the span is guided only laterally, thus allowing the expansion and contraction of the span and for slight variation in position of the towers. Operation is effected by means of operating cables, of which there are two pair at each corner of the span. The operating machinery, which is placed upon the span at its center, just above the roadway clearance, consists of four spirally grooved drums connected by a train of gears to an electric motor. Each of these drums controls the operating ropes for one corner of the span; one pair of operating ropes, leading from the top of the drum, passes over a deflecting sheave at the corner of the span, thence downward and connects near the bottom of the tower; and a corresponding pair of operating ropes leading from the bottom of the drum passes under a deflecting sheave at the corner of the span, thence upward and connects near the top of the tower. All of the drums are similarly connected so that when they are operated in one direction the ropes leading to the tops of the towers are wound on the drums, and those leading to the bottoms of the towers are payed off, lifting the span by the force exerted upon the corner sheaves. The machinery for operation is thus exceedingly simple, consisting of one transverse shaft extending across the span; one pair of reduction gears in a frame inside of the house, and the back gears upon the motor. An indicator and limit switch is provided by which the current is automatically cut off and solenoid brakes applied to the motors at near the upper and near the lower limit of the run of the span. For ordinary operation there is a hand band-brake, which is equipped with a push button switch, so that when the span is under control the operator can hold off the emergency brake, and bring the span to rest in the control of the hand brake.

To provide for emergency operation, instead of the usual hand operating capstan, the span is equipped with a 12-h. p. gasoline engine connected through a speed reducer to the machinery, so that in case of failure of electric current the operator will be able to move the span at slow speed without having to seek outside assistance. There is a manually operated lock at each end of the span in connection with a centering device so that the span may be locked down. The solenoid brakes in connection with the down-haul ropes also serve as a lock. Buss-bar trolleys are attached to the tower and a sliding contact shoe is upon the lift span to supply current to the motors during operation. The operating cables are attached at the tops of the towers to small drums with worm gear connections so that adjustment for the stretch of the operating cables can readily be made. When the span is at its upper limit the counterweights are two feet above the floor level and

a special arrangement of the trolley wires under the counterweight is made. This consists of a swinging frame upon which the trolley wires are fastened, which is pushed down by counterweights and returned to position through means of a small counter balance. The rail connections at the ends of the movable span are simple scarfed joints so that the span lifts away from the fixed rails and returns to them without any movable devices. The machinery is designed with great care and nicety. Gears and pinions which operate together are set in cast steel frames so that they will be adjusted and built complete in the shops; the adjustment of parts of the machinery in the field being reduced to a minimum. All of the gears are cast steel with cut teeth. A duplicate motor equipment with either motor of sufficient size to operate the bridge is provided.

At the ends of the fixed spans adjacent to the movable span there are provided roadway gates of substantial design to make an effective barrier across the roadway, and these are connected to derailing switches in the street car tracks so that when the gate is closed across the roadway, the derail is thrown. These gates will be manually operated and a small steel and concrete cabin is provided at each for the gate tender.

Several types of movable spans to provide the necessary channel openings for river navigation were considered, and the matter was narrowed to the selection of either a swing span or a vertical lift span. The Commissioners then desired to receive bids both upon the lift span and the swing span, and plans were prepared for the structure containing both types of movable span. The designs were made according to the same specifications and as nearly duplicate in character as possible.

Application was made to the War Department and tentative approval was received for either type of movable span, provided the swing span should have two channels, 200 feet wide, or the lift span should provide one channel 250 feet wide, with a vertical clearance of 150 feet above normal high water. Bids were received on both types of structure and it developed that the lowest bid for the bridge, including a lift span, was $70,000 less than the lowest bid for the bridge including a swing span. The lift span as above described was thereupon adopted—not only for the advantage of the lower first cost, but also because judging from the experiences of Multnomah County in operating bridges of both types, there will be continued advantage in lower cost of operation and maintenance. It is likewise most advantageous for river navigation, in that it provides a channel 250 ft. wide instead of 200 ft. wide, and the channel is not hampered by the long draw protection that would be necessary with a swing span. As the main channel is very close to the Vancouver shore, the necessary draw protection, about 500 ft. long, would have been a serious detriment to the dock frontage adjacent to the bridge.

SUBSTRUCTURE.

The river at the site of the bridge is subject to a certain amount of scour, but inspection of the soundings taken for many years past fail to disclose any indication of scour to extreme or unusual depths, although the river both for some distance up stream and some three miles down stream, is deeper than at this site. The exceptional facilities for securing piles of great length at a very reasonable cost, was a considerable factor in determining

upon the exact type of piers to be used. The piers are to be constructed of concrete, containing and resting upon piles sunk by means of water jets to a depth of about 110 ft. below low water. Open cribs of timber, braced by transverse trusses, and forming permanent parts of the pier bases, will be sunk to depths of about 20 to 25 ft. below the river bed and the piles jetted down inside the cribs, averaging about one pile to ten sq. ft. area of crib. Concrete will then be deposited through the water in sufficient quantities to seal the bottom of the crib, and after this concrete has hardened, the crib will be pumped out, the piles will be cut off a short distance below low water, and the remainder of the concrete for the pier placed in the open. A certain amount of heavy stone rip-rapping will be placed about the piers, and will be replenished, if necessary, during the first two years after the completion of the structure. The piles used will thus be about 120 feet long in single sticks, about 10 or 12 in. in diameter at the top, and about 22 in. at the butt. No followers will be used in driving, but the necessary cut-offs will be wasted. Piles of this length can be purchased at the bridge site for about 12c per linear foot. In the average piers under the 265 ft. spans there are ninety piles.

The upper ends of these piles are therefore embedded into the concrete of the bases of the piers from 15 to 20 ft., so that the pile forms a definite portion of the pier. It is evident that even though some unusual scour should, on some extraordinary occasion, extend below the bottom of the base, the pier would still be perfectly stable, owing to the great depth of penetration of the piles and to the rigidity of their upper support. The occurrence of ice in the Columbia River in sheets or floes of large size is very rare, so that the concrete piers need no special protection of steel or stone facing.

The shafts of the piers above the base are comprised of two cylindrical battered columns, one placed under each pair of shoes. These columns are joined by a vertical diaphragm and by a horizontal coping at the top, both of which are reinforced with steel. This design saves considerable weight which otherwise would require supporting piles, and eliminates a large amount of concrete unnecessary for any structural purpose.

SLOUGH CROSSINGS.

The bridges over the sloughs consist of deck spans providing a roadway and floor of the same type and character as previously described, except that the girders are placed 23 ft. apart transversely and a portion of the roadway and sidewalk is carried on cantilever beams, and there are other minor details of differences, such as necessary trolley poles, etc. These spans rest on concrete piers supported by piles of the same general type as described for the main river. The piles will be sunk to about the same depths, but as the likelihood of scour is much less in the sloughs, the bases are not carried as far below the river bed.

The bridge over the Oregon Slough consists of ten deck girder spans 100 ft. long, and one span 115 ft. long, making the total length, 1,137 ft. 6 in. At the present time there is no navigation in the Oregon Slough above the site of the bridge, but as there is possibility of navigation being developed above the site, it was necessary to provide for some type of movable span to furnish the necessary channel openings for vessels. Permission was secured from the engineers of the War Department to build the structure

with all fixed spans at the present time, with the provision that one span is so arranged that at any time in the future, when it may become necessary, it can be converted into a movable span by providing towers at each end, and by equipping it with machinery, counterweights, etc., so that it may be operated as a vertical span. The 115 ft. span, above mentioned, is arranged for such possible use and will afford a channel 100 ft. wide. This provision and arrangement saves the Commission an expenditure of the present time of about $30,000, and permits a movable span to be provided when necessary without discarding any parts of the present structure and without interrupting traffic.

The bridge over the Columbia Slough consists of four deck girder spans of the same general type as described for the Oregon Slough, each 75 ft. long. After the first tentative approval of the plan for this Slough bridge was given by the engineers of the War Department, the status of this Slough was changed so that there has become a remote possibility that it may at some time be considered navigable. It has therefore been agreed that should such development occur, one of these 75 ft. spans will be made to lift in the same manner as above described, providing a clear channel opening of 60 ft. in width.

EMBANKMENTS.

In the main approach on the Oregon side there will be about 1,000,000 cubic yards of embankment and on the secondary approach there will be about 500,000 cubic yards. The embankments will be made of sand dredged, probably from the Oregon Slough. The material will be lifted by suction dredges and will be transported to position through pipes. For the main fill there is being installed a 24 in. suction dredge with electrically operated pumps, which will deliver the material about 5,000 ft. At this point there will be installed a booster pump, also electrically operated, so that for the extreme end of the approach, the material will be carried through about 10,000 ft. of pipe. The embankments are to be 42 ft. wide on top with side slopes of two to one, and average 20 to 25 ft. high. The up-stream side of the embankment will be protected to an elevation of about 20 ft. above low water by concrete slabs laid on the slope of the finished embankment. These slabs are to be 4 in. thick, reinforced with wire mesh and in strips of about 8 ft. wide, extending continuously up and down the slope. The overflow water which at times inundates most of the river valley, is largely back water and has very little perceptible current, except that caused by its out flow from the river over the land as the river rises, and that caused by its return flow to the river as the river falls. The period of the most rapid current with corresponding danger of erosion, is at the time when the water is just rising above the surface of the ground and at the time when it is falling to its lowest point. The concrete protection part way up the slopes will therefore guard against erosion at these periods. It is planned to sow the remainder of the slopes with grass seed, in an attempt to develop a compact sod covering the sides. At the foot of the slopes it is probable there will be planted a row of ever-green blackberries, a hardy indigenous shrub, which will be of considerable value in preventing erosion. Around the ends of the embankment at the buried piers, the concrete slope protection extends entirely over the slope of the embankment to its upper edge, thereby entirely encasing the end of the

embankment. The embankment across Hayden Island is more exposed than the other embankments and the engineers of the War Department require that some revetment or slope protection extend entirely over both sides up to five feet above the elevation of normal high water.

THE

PACIFIC HIGHWAY
INTERSTATE BRIDGE OVER THE COLUMBIA RIVER
and APPROACHES

FROM

VANCOUVER, WASHINGTON, to PORTLAND, OREGON

FOR

MULTNOMAH COUNTY, OREGON,
CLARKE COUNTY, WASHINGTON

---

*WADDELL & HARRINGTON
E. E. HOWARD, L. R. ASH
Associate Engineers
CONSULTING ENGINEERS

Kansas City, Missouri January 4, 1915

*This firm has been dissolved and the work has been carried out by Mr. Harrington and Mr. Howard

THE

PACIFIC HIGHWAY
INTERSTATE BRIDGE OVER THE COLUMBIA RIVER
and APPROACHES

FROM

VANCOUVER, WASHINGTON, to PORTLAND, OREGON

FOR

MULTNOMAH COUNTY, OREGON,
CLARKE COUNTY, WASHINGTON

NOTICE TO CONTRACTORS

Bids received until February 23, 1915.

COLUMBIA RIVER INTERSTATE BRIDGE.

Portland, Oregon.

Sealed proposals will be received by the Columbia River Interstate Bridge Commission on February 23, 1915, at two p. m., in room 201 of Multnomah County Court House, Portland, Oregon, for the furnishing of all materials and performing of all work for the construction of the Columbia River Interstate Bridge and Approaches. The bridge and approaches are for highway and street car traffic and comprise about 5,000 linear feet of steel structure and 12,000 linear feet of embenkment; including about 9,500 tons of steel, about 1,000,000 cubic yards of embankment, and about 29,000 cubic yards of concrete. Contracts will be let under several sections to one or more bidders for a part or for the whole of the work. Payments will be in cash upon monthly estimates.

Proposals and bids shall be subject to all requirements of the specifications, plans, contract, contractors' bonds, and proposal forms; and shall be made upon blank forms provided in the specifications. The bidder to whom a contract may be awarded shall promptly execute a formal contract and shall furnish a penal bond with good and sufficient sureties satisfactory to the Commissioners in an amount eqnal to the total contract price, for the faithful performance of sald contract and all provisions thereof.

To all bids there shall be attached a certified check of the bidder, certified to by a responsible bank, made payable to Wm. N. Marshall, Secretary, of an amount of ten per cent of the total bidding price, and the bidder who has a contract awarded to him and

who fails promptly and properly to execute said contract, or bond, shall forfeit said check. The said check shall be taken and considered as liquidated damages and not a penalty for failure of such bidder to execute said contract and bond. Upon the execution of said contract and bond by the successful bidder, the said check shall be returned to him. The checks of unsuccessful bidders shall be returned to them after the contract and bond with the successful bidder are duly executed.

The contract will be awarded to the lowest responsible bidder, but the Commission reserves the right to reject any and all bids and to waive informalities. Multnomah County provides five-sevenths and Clarke County two-sevenths of the funds for payments.

Plans and specifications are on file in the office of the County Clerk of Multnomah County, Oregon, in the office of the County Clerk of Clark County, Washington, and in the office of the State Commissioner of Highways at Salem, Oregon. Copies of the plans and specifications may be secured from the Secretary of the Interstate Bridge Commission at Vancouver, Washington, or from the Consulting Engineers, Waddell and Harrington, at Kansas City, Missouri, by depositing twenty-five dollars. The amount of the deposit will be refunded upon the return of the plans in good order accompanied by a bid; or one-half the amount of the deposit will be refunded upon the return of the plans in good order without a bid.

WM. N. MARSHALL, Secretary,
County Court House.

THE

PACIFIC HIGHWAY
INTERSTATE BRIDGE OVER THE COLUMBIA RIVER
and APPROACHES

FROM

VANCOUVER, WASHINGTON, to PORTLAND, OREGON

FOR

MULTNOMAH COUNTY, OREGON,
CLARKE COUNTY, WASHINGTON

SPECIFICATIONS

1. LOCATION.

The bridge and approaches described in these specifications will extend from Vancouver, Washington, to Portland, Oregon, across the Columbia River, Hayden Island, the Oregon Slough, the Columbia Slough, and certain lands within Multnomah County.

2. OWNERSHIP AND FUNDS.

Multnomah County, Oregon, will pay all of the cost of the Oregon approach and three-fifths of the cost of the bridge over the Columbia River. Clarke County, Washington, will pay two-fifths of the cost of the bridge over the Columbia River. The bridge and its approaches will be constructed by the Columbia River Interstate Bridge Commission, which is composed of the Commissioners of Multnomah County, Oregon; the Governor of Oregon, acting as a commissioner of Multnomah County; and the Commissioners of Clarke County, Washington.

3. GENERAL DESCRIPTION.

The bridge over the Columbia River will consist of a number of through riveted truss spans and one girder span resting on concrete piers which are supported on piles. To provide for passage of river traffic there will be included either a swing span with its pivot pier and timber protection or a vertical lift span. Plans have been prepared and tenders will be received for both types of movable span, and selection will be made after bids are considered.

The bridge over the Oregon Slough will consist of a number of deck plate girder spans resting on concrete piers which are carried on piles. One span is arranged for the addition of the machinery necessary to make it operative in case the War Department should at any time, for the interests of navigation, require a movable span. The bridge over Columbia Slough will be of the same character as that of the Oregon Slough, but without a movable span.

Embankments will be constructed at the Vancouver end of the Columbia River Bridge, across Hayden Island, between Oregon Slough and Columbia Slough, and from Columbia Slough to Columbia Boulevard at the intersection of Union Avenue.

The steel structures will have reinforced concrete slab floors, bituminous pavement, one concrete sidewalk, and track rails for both narrow and standard gauge electric railways.

The embankments will provide a roadway, but no sidewalks except in Vancouver. The roadway throughout will be thirty-eight feet wide between curbs, and the electric railway tracks will be placed in the middle.

Certain piers will be rip-rapped or otherwise protected, and portions of the embankments will be rip-rapped, paved, or otherwise protected.

The tracks on embankments, the overhead trolley construction throughout, the lighting brackets, and other lighting equipment for the roadways, will not be included under these contracts, but connections for trolley poles, light brackets, etc., are to be provided.

The total length of steel structure is about five thousand feet; the total length of embankments about twelve thousand feet; making the whole length of structure about seventeen thousand feet.

4. ACCOMPANYING DRAWINGS.

The following Engineers' drawings accompany and supplement these specifications. In case of disagreement between these drawings and the specifications, the specifications shall govern:

Sheet

1. General Map.
2. Map Vancouver and Hayden Island before Improvement.
3. Map Vancouver and Hayden Island after Improvement.
4. General Plan and Profile with Swing Span.
5. General Plan and Profile with Lift Span.
6. Profile and Embankments.
7. Details of Floors on Spans.
8. Floor System and Shoes.
9. 261-foot, 11¼-inch Span—Trusses—L^0 to L^3.
10. 261-foot, 11¼-inch Span—Trusses—L^4 to L^5.
11. 271-foot, 9½-inch Span—Trusses—L^0 to L^3.
12. 271-foot, 9½-inch Span—Trusses—L^4 to L^5.
13. 271-foot, 9½-inch Lift Span—Lifting Girder.
14. Towers, Top Section.
15. Towers, Third Section.
16. Towers, Second Section.
17. Towers, Bottom Section.
18. Stairs, Walkways and Ladders—Lift Span.
19. Operator's House and Beams—Lift Span.
20. Gates and Handrails.
21. 48-foot Girder Span.
22. Counterweights.
23. Substructure, Bridge with Lift Span, Piers 1 to 13.
24. Substructure, End Piers, Columbia River.

25. Substructure, Oregon Slough.
26. Floor System, Oregon Slough.
27. Girders, Oregon Slough.
28. Lift Span Girders, Oregon Slough.
29. Substructure, Columbia Slough.
30. Girders, Columbia Slough.
31. 224-foot, 9 3-16-inch Span.
32. 480-foot, 6-inch Swing Span—Trusses L^0 to L^2.
33. " " L^3 to L^8.
34. " " L^7 to L^9.
35. " " Tower.
36. " " Supporting Girders.
37. 480-foot, 6-inch Swing Span—Drum.
38. " " Drum Bracing, Rock, Tracks, Rollers, etc.
39. " " Machinery House and Beams, Operator's House.
40. " " Floor System.
41. Substructure, Bridge with Swing Span—Piers 1 to 14.
42. Draw Protection for Bridge with Swing Span.
43. Track Layout, Vancouver.
44. Ornamental Concrete Posts, Lamp Brackets, Gate Tenders' Houses.
45. Gauge Readings—Mats and Rip-Rap—Loadings.
46. Miscellaneous.

M 1. Tower Sheave and Bearings—Lift Span.
M 2. Equalizers and Ropes—Lift Span.
M 3. General Arrangement Machinery—Lift Span.
M 4. Indicator and Miscellaneous Details—Lift Span.
M 5. Street Car Trolley Breaker—Lift Span.
M 6. Marking Diagram—Lift Span.
M 7. Span Locks—Lift Span.
M 8. Details of Operating Machinery—Swing Span.
M 9. End Lift Machinery—Swing Span.
M10. End Lift Machinery and General Arrangement of Machinery—Swing Span.
M11. Mechanical Indicator and Miscellaneous Details.

5. RIVER CONDITIONS.

The U. S. Engineers' Corps maintains a gage at the mouth of the Willamette River, and the Weather Bureau maintains a gage at the foot of Columbia Street in Vancouver. Records of the readings can be secured from the offices in Portland. Tables shown on the drawings are abbreviated from the official record. As may be noted, the highest waters usually occur in June, and the periods of low water are from September to February, but there are years in which there are exceptions.

In preparing tenders, each Contractor is to be governed by his own judgment of probable river conditions, and the actual resulting conditions will in no way be considered as unforseen.

6. PLANT AND PROGRAM OF CONSTRUCTION.

Before beginning work the Contractor shall prepare a program of construction, which shall be made satisfactory to the Engineers, and shall show the order and time in which the various parts of the work are to be done, the progress of the work, month by month, and the methods of construction to be employed. This program may be modified only with the approval of the Engineers, and carrying out the work in accordance with it shall be considered an obligation of the contract.

The Contractor shall supply plant, tools, and equipment of every kind, ample in quantity and capacity, in good working order, and suitable in character, to carry on the work according to program. Promptly upon entering into contract to do the work, the Contractor shall submit to the Engineers for their approval a full inventory of the equipment to be employed, but approval by the Engineers of program or of plant or of equipment or of both shall modify none of the Contractor's obligations.

7. WORKING DRAWINGS.

The Contractor shall prepare all detailed working drawings required to enable him to fabricate, erect and construct all parts of the work in strict conformity with the Engineers' drawings and with these specifications.

These working drawings shall include, in addition to the necessary shop drawings, camber diagrams and erection diagrams which show clearly the marks and positions of each member.

For reinforced concrete construction, the working drawings shall show the dimensions and shape, or bending diagrams, for all reinforcement, locating its position in the work, special details and connections of reinforcement, and all forms and the means of supporting them.

For substructure and all general construction the working drawings shall show all minor and special details which are left open to the Contractors' choice of methods of construction or which for any reason are not fully shown on the Engineers' drawings.

For all construction the Contractor's working drawings shall show details of falsework, rigging, and all other temporary structures, and sizes, capacities and other characteristics of all machinery and plant employed.

Working drawings shall be submitted to the Engineers in duplicate; one set will be returned to the Contractor approved, or showing the changes or corrections required; duplicate copies shall be resubmitted after correction, until they receive the Engineers' approval. Working drawings shall be corrected or revised whenever and however the Engineers direct, but no approved working drawings shall be altered and the Engineers' drawings shall not be deviated from without the written consent of the Engineers.

The Contractor shall carefully check all drawings, the Engineers' as well as his own, and if any errors be found they shall be reported to the Engineers who will make or approve the necessary corrections. The Contractor having undertaken to construct a structure complete for the purpose intended, and having checked all plans, shall be responsible for the correctness of all drawings, as to dimensions, elevations, and mutual correlation of various parts; and it is expressly understood that the Engineers' approval of the drawings does not in any measure relieve the Contractor from full responsibility for such errors.

Payment for working drawings shall be included in the prices for materials named in the contract. For minor revisions of completed and approved working drawings no extra payment will be made; for material revisions for which, in the Engineers' opinion the Contractor is fairly entitled to extra compensation, the Engineers will fix the amount that the Purchaser shall pay and the Contractor accept as full payment for such revisions.

The Contractor shall furnish without additional charge two complete sets of cloth and as many sets of paper blue print copies of the working drawings as the Purchaser and the Engineers may desire.

8. REPORTS OF MATERIALS AND MEN.

The Contractor shall deliver to the Engineers as soon as they are prepared, duplicate copies of all bills of material designed for use in the permanent structure, in falsework, or in plant; and the Contractor shall make duplicate daily reports to the Engineers of the amount and description of all materials received, all materials his advices show to be shipped, and of the number and classification of men employed upon the work. Prices of materials and the rates of pay of men need not be given.

9. MATERIALS AND WORKMANSHIP.

The nature and spirit of these specifications and of the contracts are to provide for the work enumerated to be fully completed and suitable in every detail for the purpose

designed, and it is hereby understood that the Contractor in accepting the contract agrees to furnish anything and everything necessary for the construction, even though not specifically mentioned in the drawings or specifications. Wherever not explicitly specified, it is the general intent of these specifications to provide for first-class materials and workmanship of every class in all parts of the structure.

The Contractor shall employ workmen, mechanics, and tradesmen, and other employees, trained and skilled in their various occupations.

The Contractor shall perform his work in proper sequence in relation to the work of other Contractors as may be directed by the Engineers and shall properly join his work to existing or new constructions.

10. ENGINEERS' DIRECTIONS AND INSPECTION.

The work shall be carried out and the construction completed according to the plans and specifications, and according to the instructions of the Engineers.

The Contractor's proceedure and methods of construction may be of his own selection provided they secure results which fully satisfy the requirements of the plans and specifications, but they must be made to meet the approval of the Engineers.

Any directions or instructions which the Engineers or their representatives may give shall be followed and conformed to by the Contractor, his employees and agents of every kind.

On request of the Contractor or his representatives any verbal directions given by the Engineers or their representatives will be repeated in writing. Upon direction of the Engineers, the Contractor shall discharge immediately and shall not re-employ on the work any superintendent, foreman, employee, or agent of any kind whose presence the Engineers shall deem in any way prejudicial to the work.

Sub-contractors or agents of any kind of the Contractor are agreed to be employees of the Contractor and must conform to the directions and supervision of the Engineers in the same way as all other employees.

All materials and every process and operation of manufacture, construction and erection shall be subject to the inspection of the Engineers at all times, and the Engineers and their representatives shall have free access to all parts of any factories or plants in which any materials are being manufactured or prepared, and to all parts of the work of construction and erection. Every facility for inspecting the workmanship and testing the qualities of materials desired by the Engineers or their representatives shall be furnished by the Contractor without any additional charge except the price payments for completed construction provided in the contract. The Engineers shall have the right to take such samples of all materials as they consider necessary for testing or examination, and all required tests for materials, other than cement, are to be made by the Contractor without extra charge.

Rejected materials or supplies must be removed at once from the site or the vicinity of any process or work, and from the right-of-way; and workmanship or processes deemed to be faulty must be corrected immediately upon request.

The Contractor, upon being so directed by the Engineers, shall remove, reconstruct, or make good as may be directed, without charge, any work which the Engineers may consider to be defectively executed. The fact that materials or workmanship so considered defective had been previously accepted by the oversight or error of judgement of the Engineers' inspectors or other representatives shall not relieve the Contractor from the obligation to remove, correct, or make good such defects.

Metal will be inspected at the mills and shops. Inspection and tests will be made as soon as practicable after it is rolled or cast and inspection of workmanship at as early a period as possible as the manufacture of material progresses. Ample notice shall be given the Engineers of beginning the operations to allow for arrangement for inspection. Complete copies of mill orders shall be furnished to the Engineers in advance of mill work.

All other materials, processes, and workmanship than metal work and its manufacture, will be inspected at the site of the structure, but if the Contractor desires that any of them be inspected elsewhere, the Engineers shall inspect them at the place designated by the Contractor, but all expenses incurred in making such inspection shall be borne by the Contractor and shall be paid monthly or shall be deducted from the monthly estimates by the Purchaser and paid to the Engineers.

When the structure is ready for final inspection, the Contractor shall notify the Engineers in writing that his work is so ready. The Engineers will make such final inspection either in person or by competent representatives. After defects or omissions noted by such final inspection are made good the work will be accepted and paid for in full, except where there are provisions to the contrary.

11. POSITION, GRADIENT AND ALIGNMENT.

The entire structure and each part thereof must be constructed in the position required, the finished surface of the roadway must conform exactly to the elevations and gradient specified, and all parts of both substructure and superstructure must be in exact alignment and properly adjusted. The Contractor must provide all frames, forms, falsework, shoring, guides, anchors, and temporary structures that may be required to insure these results; and the prices stated in the contract cover and include all such work, materials and constructions.

Contractors will be given bench marks and points at various intervals throughout the structure, but they will provide their own men and instruments for determining alignment, elevations, and positions for all construction between such points, subject to the check and correction of the Engineers. The Contractors shall furnish without extra charge such assistance as the Engineers may require in placing of points, stakes, and determining lines and elevations.

12. CHANGE IN AMOUNT OF WORK.

The Engineers shall have the power to vary, extend, increase or diminish the quantity, to change the order or type of work or dispense with a portion thereof at any time without impairing the contract, without changing the unit prices to be paid, without in any way impairing the bond or releasing the sureties thereof; and no payment of any kind will be made on account of work not done. In case of reduction of amount, if the total sum paid to the Contractor for the whole work done on the given contract is as much as ninety per cent of the sum which would have been paid if no change had been made, no allowance will be due except payment for actual amounts done; but if the total amount is less than ninety per cent, an allowance will be made, and will be paid by the Purchaser, on account of administration and plant costs, such amount to be fixed by the Engineers. In case of increase of amounts of work, payment for the whole quantities at the unit prices bid for the work of the classes so increased, shall be full and complete compensation for the work done, no matter how much increased. In case the change involves the execution of work of a class not herein provided for, the Contractor shall, on direction of the Engineers, perform same as provided for in the clause Unclassified Work.

13. DAMAGES AND ACCIDENTS.

The Contractor shall assume and be responsible for, and shall indemnify and save harmless the Purchaser against all claims and demands of all parties whatsoever for damages or for compensation for injuries or accidents to persons, animals and materials due either directly or indirectly to his operations until the final acceptance of the structure.

The Contractor shall bear all loss or damage, from whatever cause arising, which may occur to the works or to any portion of them, until the same are fully and finally completed and delivered to and accepted by the Purchaser; and if any such loss or damage occur before such final acceptance, the Contractor shall immediately, at his own expense, repair, restore, and re-execute the work so damaged, so that the whole work may be completed within the time limit.

The Contractor shall place sufficient and proper guards for the prevention of accidents, and shall put up and maintain at night suitable and sufficient lights.

14. LEGAL RESTRICTIONS, PERMITS, ETC.

The Contractor shall procure all necessary licenses and permits, and shall give due and adequate notices to those in control of all properties which may be affected by his operations. The Contractor shall conform to all laws, regulations, or ordinances with regard to labor employed, hours of work, and his general operations.

The Contractors are requested to give particular attention to the provisions of statutes of both Washington and Oregon relative to the employment of labor on public works; and to the provisions of the Workmen's Compensation Acts, and similar laws.

15. OFFICES FOR COMMISSIONERS AND ENGINEERS.

The Contractor for Substructure shall provide without extra charge at or near the site of the works, as may prove acceptable, for use until the completion of the bridge, an office room with table and chairs, for the use of the Engineers and their representatives; and an office room with table and chairs for the use of the Interstate Bridge Commission and their Secretary.

16. INTERFERENCE WITH TRAFFIC.

The Contractor and his employees shall so conduct their operations that they shall not close any thoroughfare nor interfere in any way with traffic on the railways, highways, or the water, without the written consent of the proper authorities, or as otherwise provided in these Specifications.

17. FERRY ON RIVER.

The clause of Interference with Traffic applies especially to the ferry operated by the Portland Railway Light and Power Company. At the south side of the river a portion of new runway to the ferry slip will have to be constructed before the embankment over the present runway is built. The buried pier there shall be built without seriously interfering with roadway traffic. At the north side of the river the present slip and runway will be abandoned and a temporary slip and runway built. The present slip and runway shall be kept in operation as long as is reasonably possible, and until the beginning of the embankment and of the buried pier shall make the approach unserviceable.

18. REMOVAL OF DEBRIS.

Upon completion of the structures, all surplus material, temporary structures, and debris resulting from construction, reconstruction, or removal of old structures, and timbers, cofferdams, sheeting around piers, pedestals, and abutments, shall be removed, and the premises shall be left in neat, orderly condition. Falsework timbers and piles are to be removed to the level of the ground, or level of the riverbed, or as directed. The river and channel must be cleared of all piles, falsework and debris to the satisfaction and acceptance of the Engineers of the War Department; and such acceptance must be secured in writing by the Contractor before removing his equipment from the site. No special payment will be made for the removal of debris, its cost and value being covered by the prices paid for construction in place.

19. METAL.

Metal not otherwise specified shall be medium steel. Rivets and bolts shall be of rivet steel; rolled shafts and pins of machinery steel; forgings of the steel hereinafter specified for forgings; bushings of bronze, unless otherwise specified; washers on timber of malleable iron; and castings of cast steel unless otherwise specified. All steel shall be manufactured by the open hearth process.

20. CHEMICAL COMPOSITION OF STEEL.

The phosphorus and sulphur shall not exceed the percentages as follows:

	Rivet Steel Forging Steel	Medium Steel	Steel Casting	Machinery Steel
Phosphorus				
(Basic:	0.04 per cent	0.04 per cent	0.05 per cent	0.04 per cent
(Acid:	0.04 per cent	0.06 per cent	0.08 per cent	0.06 per cent
Sulphur	0.04 per cent	0.05 per cent	0.05 per cent	0.05 per cent

21. CHEMICAL DETERMINATION OF STEEL.

Chemical determinations of the percentages of carbon, phosphorus, sulphur, and manganese, shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel, and a correct copy of such analysis shall be furnished to the Engineers. Check analysis shall be made from finished material if called for by the Engineers, in which case twenty-five per cent in excess of the above limits will be allowed.

The ultimate tensile strengths of steel shall be within the following limits:

22. PHYSICAL REQUIREMENTS FOR STEEL.

Rivet steel	46,000 pounds to 54,000 pounds
Steel for forgings	not less than 80,000 pounds
Medium steel	60,000 pounds to 70,000 pounds
Machinery steel	70,000 pounds to 80,000 pounds
Cast steel	not less than 65,000 pounds

The elastic limit shall be not less than fifty-five per cent of the ultimate strength; excepting steel for forgings for which the elastic limit shall be fifty per cent of the ultimate strength.

All fractures must be silky and of uniform color, except that a fine granular fracture will be permitted in cast steel.

For rivet steel and medium steel the percentage of elongation in eight inches as determined on the test specimens shall be not less than 1,500,000 divided by the ultimate tensile strength, except that for material less than 5-16 inch and more than ¾ inch in thickness the following modifications will be allowed:

For each 1-16 inch in thickness below 5-16 inch, a deduction of 2.5 will be allowed from the specified percentage.

For each ⅛ inch in thickness above ¾ inch, a deduction of 1 will be allowed from the specified percentage.

For pins and rollers over 3 inches in diameter a deduction of 5 will be allowed from the specified percentage.

For steel for forgings, the elongation in two inches shall be not less than twenty-two per cent. For machinery and steel and for steel castings, the elongation in two inches shall be not less than eighteen per cent.

23. TESTS FOR PHYSICAL REQUIREMENTS OF STEEL.

The tensile strength, elastic limit, and elongation shall be determined by loading to the point of rupture a specimen of not less than one-half square inch in section and not less than one-quarter of an inch in thickness, cut and planed or turned from a full-size section to a uniform section at least one inch longer than the length for which elongation is to be measured. The test specimens shall be cut by the mill from finished material selected by the Inspector, and shall be so selected that the different sizes and shapes in the order shall be as nearly represented as possible. Every melt from which material is furnished must be represented by the tests.

Specimens of medium steel cut from material less than one inch thick shall bend when cold without fracture 180 degrees and close down flat upon themselves without showing signs of cracking. Full-size material for eye-bars and other steel one inch thick and over, tested as rolled, shall bend cold 180 degrees around a pin, the diameter of which is equal to twice the thickness of the bar, without fracture on the outside of the bend. Angles three-fourths inch and less in thickness shall open flat, and angles one-half inch and less in thickness shall bend shut, cold under blows of a hammer without sign of fracture. This test will be made only when required by the Inspector.

Rivet steel specimens shall bend through 180 degrees flat upon themselves without cracking on the outside of the bent portion. Rivet rods shall be tested as rolled.

Specimens of cast steel and machinery steel shall bend cold ninety degrees around a pin whose diameter is three times the thickness of the specimen without showing signs of cracking.

Specimens of steel for forgings one inch by one-half inch in cross section shall bend when cold one hundred and eighty degrees around a bar one inch in diameter, without fracture on the outside of the bent portion.

For pins and rollers, specimens shall be cut from the finished roller, or forged bar in such manner that the center of the specimen shall be one inch from the surface of the bar.

Medium steel shall be so ductile that drifting rivet holes, punched within two inches of a sheared edge, till their diameters are increased fifty per cent shall not crack the metal. Machinery steel shall not crack when similarly tested till the rivet hole is increased twenty-five per cent in diameter.

At least two tensile tests and two bending tests shall be made on specimens from different ingots of each melt, except in the case of small melts, for which the number may be reduced to one. A bending test shall be made with each tensile test, if required, and may, if desired, be made on the broken test pieces of the tensile tests.

If material for various shapes is to be made from the same melt, the specimens for testing are to be so selected that they represent the different shapes rolled from such melt. Lots for testing shall not exceed twenty tons in weight; and plates rolled in universal mills or grooves, or sheared plates, shall constitute a separate lot, as shall also the angles, channels, or beams.

The number of tests of steel castings will depend upon the character and importance of the castings. Specimens shall be cut from coupons moulded and cast on some portion of one or more castings from each melt or from sink heads, if the heads are of sufficient size. The coupon or sink head so used shall be annealed with the casting before it is cut off.

For forgings, one test specimen shall be made for each ten forgings of each kind; but not less than two specimens shall be made for any single kind of forgings. Test specimens shall be cut cold from the forging or a full size prolongation of the same, made parallel to the axis of the forging. The specimens shall be taken half way between the center and the outside, and shall be cut parallel to the direction in which the metal is most drawn out or worked.

The inspector will be permitted considerable latitude in respect to the number of tests required, reducing it when the metal runs uniformiy and increasing it when it does not. Every melt from which material is furnished must be represented by the tests. Material which is to be used without annealing or further treatment shall be tested in the condition in which it comes from the rolls. When material is to be annealed, or otherwise treated for use, the specimens for tensile tests representing such material shall be cut from properly annealed or similarly treated short lengths of the full section of the bar.

Material which, subsequent to the above tests at the mills, and its acceptance there, develops weak spots, brittleness, cracks, or other imperfections, or is found to have injurious defects, will ba rejected at the shop and shall be replaced by the manufacturer at his own cost.

24. FINISH OF ROLLED STEEL.

Finished material, as it comes from the rolls, shall be free from seams, flaws, cracks, defective edges, or other defects, and have a smooth, uniform, workmanlike finish. Plates thirty-six inches in width and under shall have rolled edges.

25. PLATES.

Plates rolled on the universal mill may be rolled from slab ingots, but all other plates shall be rolled from slabs made by rolling an ingot and cutting off the scrap. The ingot shall have at least twice the cross-sectional area of the slabs made from it, and the slabs shall be at least six times as thick as the plates made from them.

26. FORGINGS.

Forgings shall be free from cracks, flaws, seams, or other injurious imperfections, shall conform to the dimensions shown on the drawings, and shall be made and finished in a workmanlike manner. All forgings shall be annealed. No forging shall be done at less than red heat.

27. STEEL CASTINGS.

Steel castings shall be free from injurious blow holes, true to pattern and of workmanlike finish. All steel castings shall be thoroughly annealed, sufficient time being taken to insure annealing throughout.

When the bearing surface of any steel casting is finished, there shall be no blow holes visible exceeding one inch in either dimension nor exceeding one-half square inch in area. The length of blow holes cut by any straight line laid in any direction shall never exceed one inch in any foot.

The correction of defects in castings by welding electrically, by thermit, or by similar processes will not be permitted.

Castings shall be properly cleaned, and all fins, seams and other irregularities shall be removed, so that they shall have clean, smooth surfaces.

28. IRON CASTINGS.

Except where chilled iron is specified, all iron castings shall be of tough gray iron, with not more than 0.10 per cent sulphur. They shall be true to pattern, out of wind, and free from flaws and excessive shrinkage. They shall be substantially of the thicknesses required by the plans, and they shall have sharp and clean angles, lines, mouldings and filleted corners.

Tests shall be made on a round bar, one and one-quarter inch in diameter and fifteen inches long. The transverse test shall be made on a length of twelve inches with a load at the middle. The minimum breaking load so applied shall be 2,900 pounds with deflection of at least one-tenth inch before rupture.

29. PINS AND SHAFTS.

Pins and shafts up to six inches in diameter, unless otherwise specified, may be rolled; those of greater diameter shall be forged. The rounds from which the pins and shafts are to be turned must be true, straight, and free from all injurious flaws or cracks. All forged pins and shafts shall be reduced to size from a single bloom or ingot until perfect homogeneity is secured throughout the whole mass. The blooms or ingots shall have at least three times the cross-sectional area of the finished pins or shafts made from them.

Pins five inches and greater in diameter for equalizing levers and bars connecting suspending cables to structural parts shall be of forged steel; corresponding pins less than five inches diameter shall be made of rolled machinery steel.

30. BRONZE BUSHINGS.

Bronze bushings shall be composed of bronze of composition: Copper 79.7 per cent, Tin 10.0 per cent, Lead 9.5 per cent, Phosphorus 0.8 per cent.

The amount of tin shall not be less than nine per cent nor more than eleven per cent. The amount of lead shall not be less than eight per cent nor more than eleven per cent. The amount of phosphorus shall not be less than seven-tenths nor more than one per cent. The amount of ingredients other than copper, tin, lead and phosphorus shall not exceed one-half of one per cent.

31. MACHINERY.

Unless otherwise indicated on the drawings, cast portions of the machinery shall be made of cast steel and rolled shafts and pins shall be made of machinery steel.

The machinery shall be finished and machined according to the best machine shop practice, to the satisfaction of the Engineers; and the limits of accuracy which the Contractor desires to observe in machining the work and the allowances for taper-shrinkage, or pressed fits, shall be placed on the Contractor's working drawings, but the approval of said drawings by the Engineer shall not relieve the Contractor from full responsibility for the satisfactory construction and operation of the machinery. The Contractor shall furnish the Purchaser with guarantee satisfactory to the Purchaser to replace, and shall replace free of charge, erected and adjusted in the structure, any and every part which may fail or otherwise prove to be defective within one year of the date on which the

bridge is put in service. If the Contractor have any objection to any features of the machinery, as designed, he must state his objection immediately, before any parts are manufactured, in writing to the Engineers; otherwise his objections will be ignored, if offered as excuse for defective or broken machinery.

Parts of the machinery in contact with other parts or with its supports shall be machined so as to provide true bearing; and surfaces in rotating or sliding contact with other surfaces shall be finished true to dimensions and polished. All bearings shall be provided with oiling devices satisfactory to the Engineers. Bushings shall be oil grooved and scraped to a true fit on the journals. Other surfaces shall be left in a neat and workmanlike condition, but need not be machined for the sake of appearances. Bearings shall be attached to their supports with turned bolts and dowels shall be added if the Engineers require them. Drainage holes of adequate size shall be drilled in all places where water is likely to collect.

Journals shall be turned with a fillet at each end, unless otherwise called for on the drawings, and shall have a good, workmanlike fit in their bearings. Hubs of wheels, pulleys, couplings, etc., shall be bored to fit close on the shaft or axle. If the hub performs the function of a collar, the end next to the bearing must be faced. Holes in hubs of toothed gear wheels must be bored concentric with the pitch circle. Gears shall be made of cast steel and shall have cut teeth of the involute type having twenty degrees obliquity. Bearings shall be bushed, as shown in the drawings. Pinions shall be made of forged steel and shall have their teeth cut from the solid metal.

The principal parts of the machinery on the movable span, and the portions of the structural steel work which support it, shall be assembled in the shop, and all holes, for connection of the machinery to the steel work shall be drilled while the parts are thus assembled. Bolts for connecting the various parts of the machinery to other parts or to the steel work shall be turned to a driving fit wherever shear may come upon them. Unfinished bolts may have a play of one-sixteenth inch in bolt holes. All turned bolts shall have the diameter of the shank at least one-sixteenth inch greater than the diameter of the threaded portion, and unless otherwise called for on the drawings, they shall have a driving fit in the bolt holes.

32. TOWER SHEAVE BEARING CONNECTIONS.

Each pair of bearings for the main sheaves at the tops of the towers shall be assembled, aligned and adjusted to correct relative positions with their shafts placed in them, on a steel plate not less than one-quarter inch thick, and holes shall be drilled through the plate corresponding to the holes for bolts in the bearings. The plate shall then be placed and exactly aligned on the tops of the columns and the corresponding bolt holes drilled. A separate plate shall be used for each pair of bearings, and the plate shall be not shorter than the total length of the shaft nor narrower than the total width of the bearings.

33. TRACK AND DRUM ROLLERS.

The segments for both upper and lower tracks shall be planed on both upper and lower surfaces and at the joints. The surfaces on which the rollers bear shall be planed to the true bevel and have the correct center line for the rollers plainly scribed thereon. The segments of the rack shall be accurately fitted to the track, particular care being taken to make the ends abut properly and to have the pitch of the teeth accurate at the joints. The teeth may be cast but the periphery and the upper ends of the teeth shall be planed and the latter shall have pitch line scribed thereon. The track and rack segments shall be adjusted so as to have the pitch line of the rack exactly concentric with the center line of the track. The rollers shall be accurately turned to exact diameters and bevel, and the center line of the roller corresponding to the center line of the tracks shall be plainly scribed thereon. The hubs shall be accurately bored and shall be faced at each end.

34. ASSEMBLY OF DRUM AND SUPPORTS.

The transverse and longitudinal loading girders, the drum and everything below them, including tracks, racks, center pivot and attachments, and machinery shall all be

assembled and adjusted at the shop. All parts shall be match-marked so they may be, and they shall be, erected at site in the same positions.

35. WIRE ROPE AND SOCKETS.

A. All wire rope shall be made by John A. Roebling's Sons Company, or some other manufacture specifically approved in writing by the Engineers.

B. The counterbalance ropes shall be made of plough steel wire and shall consist of six strands of nineteen wires each, laid around a hemp center.

C. All ropes shall be laid up in the best possible manner and shall be thoroughly soaked in an approved lubricant during the process of manufacture.

D. The ropes shall be made from wire which has been tested in the presence of an Inspector designated by the Engineers and which, for sizes 0.076" to 0.150" in diameter (the limiting values used in counterbalance ropes) exhibits the following physical properties:

a. The tensile strength per square inch shall not be less than 225,000 lbs. for wire 0.150" to 0.126" nor less than

230,000 lbs. for wire 0.125" to 0.101" diam. nor less than

235,000 lbs. for wire 0.100" to 0.076" diam.

b. The total ultimate elongation measured on a piece 12" long shall not be less than 2.4 per cent.

c. The number of times a piece 6" long can be twisted around its longitudinal axis without rupture shall not be less than 1.4 divided by the diameter in inches.

d. The number of times the wire can be bent 90 degrees and straightened alternately to the right and to the left over a radius equal to twice its diameter without fracture shall be not less than six. This test shall be made in a mechanical bender so constructed that the wire actually conforms to the radius of the jaws and is subjected to as little tensile stress as possible.

E. Each rope shall, if possible, be made in one piece. Its breaking strength, as determined by test described in paragraph G, shall not be less than

5,000 lbs.	if ¼" diameter	148,000 lbs.	if 1⅜" diameter
12,000 lbs.	if ⅜" diameter	173,000 lbs.	if 1½" diameter
21,000 lbs.	if ½" diameter	200,000 lbs.	if 1⅝" diameter
33,000 lbs.	if ⅝" diameter	230,000 lbs.	if 1¾" diameter
45,000 lbs.	if ¾" diameter	264,000 lbs.	if 1⅞" diameter
71,000 lbs.	if ⅞" diameter	297,000 lbs.	if 2 " diameter
80,000 lbs.	if 1 " diameter	325,000 lbs.	if 2⅛" diameter
101,000 lbs.	if 1⅛" diameter	375,000 lbs.	if 2¼" diameter
121,000 lbs.	if 1¼" diameter	470,000 lbs.	if 2½" diameter

In case the breaking strength of the rope fall below the values cited above, the entire length from which the test pieces were taken shall be replaced by the manufacturer with a new length, the strength and physical qualities of which come up to the specifications.

F. All sockets used in connection with this rope shall be forged, without welds, from solid steel. In every case the dimensions shall be such that no part under tension shall be loaded higher than 65,000 lbs. per square inch when the rope is stressed to its ultimate strength as named above. The sockets must be attached to the rope by a method which is absolutely reliable and which will not permit the rope to slip in its attachment to the socket.

G. In order to demonstrate the strength of the rope and fastenings, a number of test pieces, not more than ten per cent of the total number of finished lengths which will be ultimately made, nor less than two from each original long length, and not more than twelve feet long, shall be cut, and shall have sockets, selected at random from those which are to be used in filling the order, attached to each end. These test pieces are to be stressed to destruction in a suitable testing machine. Under this stress the rope must develop the ultimate strength given in paragraph E. The sockets must be so fastened to the rope that there is no slipping of the rope in the basket. If slipping should occur, then the method must be changed until one is found whereby slipping can be entirely avoided. The sockets themselves shall be stronger than the rope with which they are used. If one should break during the test, then two others shall be selected and attached to another piece of rope and the test repeated and this process shall be continued until

the Inspector is satisfied of their reliability, in which case the lot shall be accepted. If, however, ten per cent or more of all the sockets tested break at a load less than the minimum ultimate strength of the rope given in paragraph E, then the entire lot shall be rejected and new ones made of stronger material.

The length of each rope from inside of bearing to inside of bearing of sockets shall be marked on the socket.

The purchaser reserves the right to test each wire rope connection, after its attachment is made, up to one-half of the ultimate strength of the rope, and if it show the least sign of weakness it shall be rejected and replaced.

The manufacturer shall provide proper facilities for making the tests and shall make at his own expense all the tests required. All tests shall be made in the presence of an inspector who represents and is paid by the Engineers.

All ropes shall be shipped in coils whose minimum diameter is at least thirty times that of the ropes, and they shall be uncoiled for use by revolving the coil, not by pulling the rope away from the stationary coil.

36. STRAIGHTENING.

All metal must be thoroughly straightened before being laid off or worked in any way.

37. BUILT MEMBERS.

Built members must, when finished, be true and free from twists, kinks, buckles, or open joints between the component pieces.

All abutting surfaces of compression members must be planed or turned to even bearing so that they shall be in as perfect contact throughout as can be obtained by such means; and all such finished surfaces must be protected by white lead and tallow before shipment from the shop.

The ends of all webs and of chord of flange angles that abut against other webs must be faced true and square or to exact bevel; and the end stiffeners must be placed perfectly flush with these planed ends, so as to afford a proper bearing. Filling plates beneath end stiffening angles must be practically flush with the said angles, and must in no case project outside of same at the bearings.

The end connection angles of stringers are to be riveted to the webs with the whole stringer assembled in an iron frame which will give the exactly correct length of stringer and the correct position of the angles.

The floor beams shall be milled on both ends over their entire area and made of exactly correct length, after the connection angles are riveted in place. The end connection angles must be so accurately fitted that not more than one-sixteenth of an inch will be taken off the angles at their roots. The abutting ends of cantilever beams shall be milled in the same manner.

No web plate shall be allowed to project beyond the flange angles or to recede more than one-eighth of an inch from faces of same.

All filling and splice plates in riveted work must fit at their ends to the flanges sufficiently close to be sealed by the paint against the admission of water; but they need not be tool finished, unless so specially indicated either on the drawings or in the specifications. Edges of spliced web plates must be faced so as to provide close contact throughout the entire depth.

All stiffeners are to have a driving fit between the flange angles.

Riveted members must have all parts well drawn together and bolted before riveting so that when finished they will be free from open joints and the component parts will lie close on each other.

No piece having an error of more than one thirty-second of an inch between centers of pin-holes, or one-fiftieth of an inch in the diameter of the pin or its hole, will be accepted.

38. ANNEALING.

In all cases where a steel piece, in which the full strength is required, has been partially heated or bent, the whole piece must be subsequently annealed. In pieces of sec-

ondary importance, where the bend is slight, the bending is to be done cold, and no annealing will be required. Crimped web-stiffeners will not require annealing. The cross beams under the concrete floor need not be annealed.

39. FILLETS AND SHEARED EDGES.

All sheared and hot-cut edges shall have not less than one-quarter inch of metal removed by planing to a smooth, finished surface. Lacing-bars, fillers, stay-plates, lateral-bracing connecting plates, top and bottom edges of plate-girder webs and ends of cover plates on girders, and ends of roller beams, will be exempt from this requirement.

No sharp, unfilleted angles will be allowed anywhere; and wherever plate or shape has been cut into, the fillets, as well as the edges of cut, must be finished so that no sign of the punched or sheared edge remains.

40. PUNCHING AND REAMING.

Holes in steel work, where not specifically excepted, shall be punched with a punch one-eighth inch in diameter less, and shall be reamed to a diameter one-sixteenth inch greater than the diameter of the rivet intended to be used. Reaming shall be done by means of twist drills, except in cases where it is impossible to use other than a tapered reamer. Holes must be at right angles to the surface of the member, and all sharp or raised edges of holes under heads must be slightly rounded off before the rivets are driven. Holes in metal thicker than their diameters shall be drilled except in base plates and minor members which carry no stress, where punching will be permitted.

Holes for both shop and field rivets in lattice bars, lattice angles and lattice connection plates, batten plates, laterals, sway braces and lug angles connecting these parts, may be punched full size. All holes in the cross beams between the concrete floor and the stringers may be punched full size.

All punched work shall be so accurately done that after the various component pieces are assembled and before the reaming is commenced, forty per cent of the holes can be entered easily by a rod of a diameter one-sixteenth of an inch less than that of the punched holes; eighty per cent by a rod of a diameter one-eighth of an inch less than same; and one hundred per cent by a rod of a diameter one-quarter of an inch less than same. Any shop-work not coming up to this requirement will be subject to rejection by the Inspector.

All parts fastened together by shop rivets for which holes are to be reamed shall be assembled and firmly bolted together before the reaming is done.

41. ASSEMBLING OF MEMBERS AND PREPARING FIELD RIVET HOLES.

Holes for field rivets, where not specifically excepted, shall be reamed while the connecting parts are temporarily assembled; or where so specified they may be reamed to an accurate steel or cast iron template not less than one inch thick.

If it is necessary to take the pieces apart for shipping or handling, the respective pieces reamed together shall be so match-marked that they may be reassembled in the final setting up. No interchange of parts after reaming will be allowed.

All trusses shall be completely assembled in the shop and the holes for field rivets shall then be reamed.

For lift span towers the longitudinal plane bracing together with each front column and back column shall be assembled and reamed. The transverse trusses which connect the main tower columns at their tops shall be assembled with the upper sections of the columns and the holes for all field rivets reamed.

The transverse bracing members connecting the main columns of the towers of the swing span shall be assembled with the columns and the holes for field rivets reamed.

Field rivet connections in the floor system shall be reamed while the members are assembled, or to a steel or iron template as specified.

42. RIVET HOLES.

Rivet holes must be accurately spaced; the use of drift pins will be allowed only for bringing together the several parts forming a member, and they must not be driven with

such force as to distort the metal about the holes. The distance between the edge of any piece and center of a rivet hole must never be less than one and a half inches, excepting for lattice bars, small angles, and where especially shown otherwise on the drawings; and wherever practicable this distance shall be at least twice the diameter of the rivet. No drifting to distort the metal will be allowed. If a hole must be enlarged to admit a rivet, it must be reamed.

43. RIVETS.

Rivets when driven must completely fill the holes, and have full heads concentric with the rivet holes. Rivets must be driven, whenever practicable, by a machine capable of retaining the applied pressure after the upsetting is completed. Elsewhere the pneumatic hammer shall be used if possible.

The rivet heads must be full and neatly finished, of approved hemispherical shape, in full contact with the surface, or be countersunk when so required, and of a uniform size for the same sized rivets throughout the work; and they must pinch the connected pieces thoroughly together. Flattened heads may be used in certain places, if necessary for clearance. Except where shown otherwise on the drawings, all rivet diameters are to be seven-eighths of an inch. No loose or imperfect rivets will be allowed to remain in any part of the metal work.

Field rivets shall be furnished to the amount of fifteen per cent plus ten rivets in excess of the nominal number required for each size.

44. PIN HOLES.

Pin holes must be bored truly parallel to each other and at right angles to the axis of the members, unless otherwise shown on the drawings; in pieces not adjustable for length, no variation of more than one thirty-second of an inch will be allowed in length between centers of pin holes.

45. PINS.

Pins shall be turned accurately to a gauge and finished perfectly round, smooth and straight. All pins, six or more inches in diameter shall fit their holes within one thirty-second of an inch. Pins less than six inches in diameter shall fit their holes within one-fiftieth of an inch. The Contractor must provide steel pilot-nuts for all pins to preserve the threads while the pins are being driven.

46. TURNED BOLTS.

When members are connected by bolts which transmit shearing stresses, the holes must be reamed parallel, and the bolts must be turned to a driving fit. The threaded portions of turned bolts shall be one-sixteenth inch less in diameter than the body of the bolt.

47. ANCHOR BOLTS.

Bed plates and bearings shall be bolted to the masonry either by fox bolts or by bolts set in the masonry during its construction. In the case of fox-bolting, the Contractor for Erection must drill all holes and set the bolts to place with Portland cement grouting.

Anchor bolts shall be of rivet steel with United States standard threads. The thickness of the nuts for anchor bolts shall be equal to or greater than the diameter of the bolt. Anchor bolts shall not be painted before shipment; and the exposed portions thereof, after erection, shall receive two coats of paint when the other metalwork is painted.

48. THREADED NUTS, ETC.

Turnbuckles and clevises must be made so strong and stiff that they will be able to resist without rupture the ultimate pull of the members which they connect, and without distortion, the greatest twisting moment to which they could ever be subjected.

The dimensions of all square and hexagonal nuts, except those on the ends of pins, shall be such as to develop the full strength of the body of the adjustable member. No round headed bolts will be allowed. All threads, except those on the ends of pins, must be of the United States standard.

49. ROLLERS.

Rollers shall be accurately turned to the dimensions shown on the drawings, and shall be true and straight and smoothly finished. The tongues and grooves in plates and rollers must fit snugly, so as to prevent lateral motion. Pedestals or bases for shoes shall be planed on both top and bottom. Bottoms of shoes shall be planed.

50. NAME PLATE.

Cast iron name plates of neat design and finish, giving the names of the officials of the Purchaser, the Engineers and the Contractors and the date, as may be specified, shall be attached to each end of the bridge; and patent plates of bronze or brass shall be attached to the movable span. No other name plates shall be permitted.

51. REINFORCEMENT.

Bars for reinforcing shall be deformed bars having their corrugations at right angles to the length of the bar. All reinforcing material shall be rolled from billets and shall be of medium steel, uniform in character, manufactured by the open hearth process. Any attempt to substitute steel manufactured by the Bessemer process, or from old steel rails, will be considered a violation of the contract, and adequate reason for its cancellation. All finished material as it comes from the mills shall be free from all flaws, cracks, or other defects, and must have a clean finish.

The steel shall conform to the following requirements: Maximum Phosphorus, basic, .04 per cent; acid, .06 per cent; Maximum Sulphur, .05 per cent; Ultimate Tensile Strength, 60,000 to 70,000 pounds per square inch; Minimum Elastic Limit, 35,000 pounds per square inch; Minimum Elongation in eight inches, 22 per cent; Minimum Reduction of area, 37 per cent.

When wire is employed, the material from which the wire is made shall conform to the above requirements for medium steel, except that the ultimate strength may exceed 70,000 pounds, but shall not fall below 60,000 pounds per square inch; and the method of fabrication shall be such that the ultimate strength of the wires after fabrication shall not be less than 60,000 pounds per square inch.

52. RAILS AND CONNECTIONS.

The rails for the street railway tracks on the steel structure shall be the Pennsylvania Steel Company's Section 277, high tee rail weighing 80 pounds per yard of rail, or other rails of equivalent section and weight satisfactory to the Engineers. They shall be connected by 26-inch splice bars designed to fit the rail having six bolts one inch in diameter with elliptical shanks and hexagonal nuts in each splice. The joints between rails are to be placed opposite. Each rail shall be fastened to each cross beam on which it rests by two Carnegie rail clips, No. 108 with elliptical holes or equivalent, having bolts three-fourths of an inch in diameter with square head and nut. The heads of the bolts shall be down and they shall be beveled so as to rest in full contact against the lower portion of the flanges of the beam. The track rails are to be erected on the steel work and to be adjusted to correct alignment and grade, and all bonding completed before any part of the concrete slabs are placed. Enough rails shall be furnished to extend two feet beyond the back walls of the buried piers at the ends of the structure over the Columbia River, the structure over the Oregon Slough, and the structure over the Columbia Slough.

There are to be two derailing switches consisting each of a standard tongue switch equipped with a spring which will hold the tongue securely to either side. These switches are to be placed in each right-hand track about 125 feet from the channel ends of the fixed river spans and are to be connected by suitable switch rods, bell cranks, and pipe connections of the usual switch throw type, with all necessary guides and adjustments to the safety gates, so arranged that the switches will be thrown, to derail the car when the gate is closed, and thrown for safe passage when the gate is open. The gates

are of a simple type, hinged to the truss members and turned through ninety degrees. The derailing switches are to be in all respects similar to the Lorain Steel Company's Guaranteed Special Work. At expansion joints between spans, as indicated on the drawings, the adjoining ends of the rails shall be fitted for manganese steel gap bars, and these bars and connections shall be furnished with the rails.

All rails, splice bars, bolts, rail clips, connections and appurtenances of every kind, not otherwise specified, shall be made by the open hearth process in accordance with the Pennsylvania Steel Company's specifications for No. 1, standard open hearth steel tee rails, except that the rails shall be sixty feet long save only where shorter lengths are required to conform to the span lengths and the location of expansion gap bars.

The special movable rail joints at the ends of the swing span, including all parts thereof excepting the rails themselves, shall be considered a portion of the machinery.

53. BONDING RAILS.

The rails are to be bonded by the use of two compressed terminal double stranded bonds, 4-0 capacity, similar to bond Type F3 of the Ohio Brass Company, 1914 Catalog No. 14, with seven-eighths inch terminal and 4-0 cables, thirteen inches long, placed under the angle bars at each and every rail joint. The bonds are to be properly compressed into freshly drilled holes in the rail web and the ends are to be soldered. Bonds of similar size and capacity are to be placed around all special work, and across expansion joints with proper allowance for expansion. Cross bonds of 4-0 cable with similar terminals similarly compressed and soldered are to be placed so as to connect all six rails across the roadway at intervals not more than five hundred feet apart. Ample contacts are to be provided at each end of the movable span, arranged so as to complete the track circuit onto the fixed spans when the movable span is in its closed position.

54. STEEL TAPES.

The Contractor who furnishes the metalwork shall, promptly after the execution of his contract, furnish the purchaser, free of charge, two steel tapes one hundred feet long, and two steel tapes three hundred feet long, all guaranteed to agree exactly with the shop standards of the manufacturer of the metalwork.

55. PAINT AND SHOP PAINTING.

The Contractor who furnishes the metalwork shall furnish and apply the paint for the shop coat.

Before leaving the shops, all metalwork shall be thoroughly cleaned of mill scale, rust, and dirt, by the use of wire brushes and scrapers, and shall be given one coat of red lead paint or other paint approved by the Engineers. Painting is to be done in a thorough and workmanlike manner, and the paint shall be thoroughly rubbed out and evenly spread over the surface of the metal in such a way as to avoid wet paint pockets. The paint to be used shall be "New Process Red Lead-in-Oil," manufactured by the Detroit White Lead Works, or "Dutch Boy Red Lead-in-Oil" manufactured by the National Lead Company; or Lowe Bros. Red Lead Lute, or other paint, as the Engineers may direct, in paste form mixed with pure boiled linseed oil; forty pounds of red lead paste shall be mixed with one gallon of oil to make about two gallons of paint. Pure turpentine Japan Drier as required may be used.

The materials for painting shall be subject at all times to inspection and analysis and the detection of any inferior quality of such material shall involve the rejection of all suspected material at hand and the scraping and repainting of those portions of the work which in the opinion of the Engineers, were painted with inferior material.

Every requirement of the clause of Field Painting shall also apply to Shop Painting where applicable.

56. SHIPPING AND SCALE WEIGHTS.

All materials shall be loaded carefully so as to avoid injury in transportation, and they shall be at the risk of the Contractor responsible for them until the bridge is erected and accepted. Metal or other material lost or damaged in transit or during erection, or

at any time before completion and final acceptance of the work, shall be replaced at his own expense by the Contractor responsible for them when lost or damaged.

Payment for pound price contracts shall be by scale weight. The scale weight of every piece except small duplicate parts which may be bundled, and of every box or bundle, shall be marked on it in plain figures. As each shipment is made, statements in triplicate, showing in detail the various classes of material taking different unit prices, the number of pieces, the marking and weight of each piece separately, shall be furnished to the Engineers and their inspectors. The Inspector must be given reasonable opportunity to check the weights of finished numbers before shipment. Not more than five per cent excess weight over the weight calculated from shop drawings of machinery parts, and not more than two and one-half per cent excess weight over the weight calculated from the shop drawings of other metal work, will be paid for by the Purchaser.

All small parts, such as rivets, bolts, nuts, pins, washers, and small connection plates, shall be strongly boxed, and the contents, as well as the shipping address, shall all be plainly marked on each box.

57. DEMURRAGE AND CARTAGE.

The Contractor for the erection of the superstructure shall unload all superstructure materials promptly upon their arrival and transport them to the bridge sites; and he shall be responsible for and shall pay any and all demurrage or other charges incurred by failure to unload cars or boats within the time allotted therefor by the transportation companies. He shall check against the shipping lists all parts and pieces of material as they are unloaded, and shall properly report same.

58. ERECTION OF STEEL.

The Contractor shall furnish all falsework, staging, barges, plant, tools and equipment, and shall erect, adjust, rivet and paint all metal work. Attention is called to the fact that before shipment from the shop, all trusses and the principal parts of the towers are to be assembled and their field holes reamed while the members are assembled. All trusses, spliced columns, and similar members will be match-marked and must be erected in accordance with such marking. The erecting Contractor shall furnish and supply without charge all necessary temporary bolts for erection. Parts are to be carefully handled and accurately assembled. Excessive hammering which will injure or distort the material will not be permitted.

Truss spans shall be erected on blocking placed so as to give the trusses the proper camber and the blocking shall be kept at proper elevation until all truss connections are completely riveted.

Bearing surfaces shall be cleaned before being placed together; rollers and sliding shoes shall be cleaned and oiled. Riveted connections shall be accurately and securely fitted up before rivets are driven. Holes which do not match shall be reamed. Drifting which will distort the metal or gouging will not be permitted. Fitting up bolts shall be placed in at least every third hole.

The Contractor will be permitted to use any method of erection that he may desire provided it meets the approval of the Engineers. It is contemplated, however, that the erection of the bridge over the Columbia River and the bridge over the Oregon Slough can most readily be erected by floating the spans into place. If the lift span is constructed in the Columbia River Bridge, it is contemplated that the fourth truss span from the Vancouver end will be temporarily omitted for the passage of river traffic while the lift span is being erected. The lift span and the two adjacent spans will be set in place on the piers; the towers constructed on the adjacent spans, and the operating machinery placed on the lift span. The suspending cables for the lift span will be attached and placed over the sheaves and the counterweight frames will be connected to them. The concrete for the counterweights can then be hoisted to forms suspended from the counterweight frame.

In case a swing span is used in the Columbia River Bridge, the span can be either floated into position or may be erected on the timber draw protection.

59. CORRECTION OF ERRORS OF CONNECTIONS.

If there should be any misfits in the connections of the steel work, of the machinery, and of the machinery to the steel work, and of the timber to the steel work, the Contractor shall be required to make all necessary adjustments and corrections in all parts to assure their proper connection. A usual amount of drifting, drilling and correcting bad connections, and of scraping, lining and preparing bearings, is expected and is to be done by erecting Contractor without additional payment. Whenever, in the opinion of the Engineers, there is found to be an unusual and unreasonable amount of correction of shop errors, or corrections of manufactured articles, the erecting Contractor shall be paid for this work as unclassified work under this contract; provided, however, when the Contractor encounters cases wherein additional payment seems properly due, he shall call the attention of the Engineers' thereto, and if they decide that an additional payment is due, they will give a written order, and the Contractor shall perform the work and shall present receipted detailed bills and vouchers for all expenses incurred as provided under the Unclassified Work clause. No claims for additional payment due on such work will be considered at all, unless a definite written order is given therefor by the Engineers before such work is started. If the Engineers decide in any such cases brought to their attention that additional payment is not proper, the Contractor shall proceed to perform the work, but no additional payments will be made and no claims therefor will be considered. All additional payments allowed the erecting Contractor for correcting shop errors shall be paid by the Purchaser and deducted from the compensation of the Contractor for the manufacture and delivery of the metal work and machinery.

60. FIELD RIVETING.

All field rivets are to be driven by pneumatic hammers of type and size to be approved by the Engineers. All rivets must be of rivet steel, and must be so heated and driven as completely to fill the holes, and they must have full and perfect heads concentric with the rivet holes, with underside of head square to shank. The shanks must be of a uniform circular section throughout and cut square at end; and they must be free from projections or imperfections which would prevent the head from fitting closely before the rivet is driven. Connections must be thoroughly fitted up and rivets so driven as to pinch the connected parts tightly together. No loose or imperfect rivets will be allowed to remain in any portion of the metal work.

The manufacturers of the metal work will provide a complete equipment of field rivets, including fifteen per cent plus ten rivets in excess of the nominal amount required for each size, and the erecting contractor will be required to furnish at his own expense any rivets above that excess which may be needed.

61. FIELD PAINT AND PAINTING.

The Contractor for erection shall furnish and apply the paint for field coats.

Before erection all surfaces which will come in contact with other surfaces, or which will be otherwise inaccessible, shall be cleaned and painted one coat of paint. Immediately after erection, and after the completion of the field riveting, all metal work shall be thoroughly cleaned of dirt, rust, loose scale, blistered paint, and paint which has been damaged in handling, concrete drippings, or any objectionable material that may be on the metal. The heads of the field rivets and all parts of metal work where the shop coat of paint is in any way damaged shall be painted one coat of red lead and oil paint of the same character as specified for the shop coat. The entire metal work shall then be evenly painted with two coats of paint: the first brown, the second black.

Cleaning and painting shall proceed by sections in amount as may be specified by the Engineers, usually consisting of one complete span, or in case of viaducts, one span and the tower or bent ahead. No operations shall be started until the previous operation is entirely completed and accepted. Thus the complete cleaning and painting of each coat on each span, or other specified section, shall be entirely completed and accepted before any part of such span or section may be touched by a succeeding coat. When any span is cleaned ready for painting, or when any coat thereof is painted, the foreman shall call the attention of the Inspector thereto, who will give permission for painting to proceed when he is satisfied that previous work is completed. At least seven days or more if the Engineers so require shall elapse after the last portion of one coat has been placed before the first portion of the next coat is applied.

Paint shall be evenly spread and thoroughly rubbed out over the entire surface of the metal. Painters shall use a dust brush, as painting proceeds, where necessary to remove dust particles that may have settled since cleaning. Thinning of paint with turpentine, benzine, or any other thinner will not be permitted, but the paint must be used in the condition delivered. Painting in the open air shall be done only in dry weather and shall not be done in cold or freezing weather or upon a damp surface. Any painting injuriously affected by cold or rain shall be entirely cleaned off and fresh paint applied.

The cleaning and painting below the floor level shall not be done until after the concrete is placed and the forms removed.

The requirements of the clause of shop painting shall also apply to field painting where applicable.

The paint to be used for the two complete field coats shall be Nobrac, manufactured by the Patterson-Sargent Paint Company, Cleveland, Ohio; Metalcote, manufactured by The Lowe Brothers Company, Dayton, Ohio, and Tockolith; RIW No. 1379 and RIW No. 49, manufactured by Toch Bros., New York, or other paints of similar character which may be selected by the Engineers; to be furnished in condition for application without the mixture of any other ingredient, and to be applied as furnished.

The Contractor doing the field painting shall furnish the paint for, and paint on two tower columns and the pier below, as may be indicated, a scale from low water mark, as zero, to the upper limit of the lift span. Every foot-mark shall be indicated, every fifth foot by a large mark, and neatly made figures eighteen inches high painted for every ten feet of height. The paint shall be of the best quality white lead and two coats of it shall be applied. On the piers a black background of a paint suitable for application to concrete shall be painted for the white marks and figures.

62. SETTING SHOES.

Bases, shoes and all superstructure metal which is to rest on masonry, including hand rails on walls, shall be set to exact position and elevation and shall be supported by iron wedges. The space between the metal and the masonry shall be filled with mortar or grout of such consistency as the Engineers may direct and composed of one part of cement and one part of sifted sand. The spaces in and above the shoes, and all parts of columns which could retain water, shall be filled, as may be directed, with concrete in the proportion of one part of cement, two parts of sand, and four parts of broken stone or gravel to pass a one-inch iron ring. The top surface is to be finished with mortar so as to drain. The cost of such work is to be included in the price paid for erection of steel.

Where anchor bolts are not already set in the masonry, the Contractor for erection must drill all holes and set the bolts to place with neat Portland cement grouting, in holes at least one-half inch greater diameter than that of the bolt.

63. INSTALLATION OF MACHINERY.

All machinery and machinery parts shall be prepared, erected, adjusted, painted, oiled, and put in perfect operating condition. If the Contractor for erection have any objection to any features of the machinery, as designed, he must state his objection within ten days after signing his contract, to the Engineers in writing; otherwise his objections will be ignored, if offered later as excuse for defective erection, adjustment, or operation.

The Contractor for erection shall furnish grease for guides, oil for machinery, and all such supplies to complete the mechanical parts for operation.

The Contractor for erection shall also maintain all machinery in adjustment and shall perform all labor and operate the bridge for the Purchaser's service for a period of sixty days after it has been accepted by the Purchaser, and put into service, without additional payment. The Purchaser will furnish the necessary electric current, gasoline and oil for such operation.

64. WIRE ROPE DRESSING.

As soon as the movable span is ready for operation, the Erecting Contractor shall furnish and apply to all ropes two coats of Whitmore's No. 1 Cable Dressing, as manu-

factured by American Specialty Company of Cleveland, Ohio, or other wire rope dressing satisfactory to the Engineers.

65. COUNTERWEIGHTS.

The counterweights shall be constructed, as shown on the accompanying drawings, of steel frames surrounded by concrete. Before the construction of the counterweight is begun the Contractor shall make blocks of concrete, not less than ten cubic feet in volume, of the materials to be used in the counterweights; these blocks, when seasoned, shall be carefully measured and weighed, to determine as nearly as practicable the probable weight of the concrete in the counterweight. Forms and falsework, both subject to the Engineers' approval, shall be constructed of ample strength to support themselves and the counterweight during construction. Counterweights must be of correct weights to balance the spans. The Contractor shall adjust and correct the entire counterweights to balance as required. The exposed surfaces of concrete of counterweights are to be painted with two coats of special concrete paint to be specified by the Engineers.

The counterweights shall be built in forms attached to the counterweight frames, which shall be connected to the suspending cables that pass over the main sheaves and attach to the lifting span.

66. GASOLINE ENGINES.

Gasoline engines of the size and make specified on the drawings, or equivalent engines acceptable to the Engineers, shall be erected and installed and properly connected with the machinery. Each engine shall be capable of developing an amount of brake horse-power ten per cent in excess of the rated capacity when operating at the normal rate of speed with gasoline as fuel, and each engine shall be tested at the manufacturer's plant to meet this condition before shipment.

Each engine shall be fully equipped with Delco distributor, coil box, dry batteries, tanks for gasoline, oil, and water, piping, tools and all needful accessories for starting and for successful operation.

67. ELECTRIC MOTORS.

Electric motors of the size, character and make specified on the drawings, or equivalent motors acceptable to the Engineers, shall be erected and installed, properly connected with the machinery and with the controllers. Each motor shall be capable of producing the maximum starting torque and the normal torques with corresponding speeds, as indicated on the performance curves shown on the drawing, when subjected to the standard tests of the American Institute of Electrical Engineers, viz., after one hour's run at rated load, the temperature of any part of the motor windings shall not exceed 75 degrees C. above the surrounding air if the temperature of the surrounding air is twenty-five degrees C. The permissible rise in temperature shall be increased or diminished one-half of one per cent for each degree Centigrade the surrounding air differs from twenty-five degrees Centigrade. Duplicate motors shall operate at substantially the same speed under the same load and voltage. Each motor shall be tested by the manufacturer before shipment, and shall demonstrate its ability to meet the above requirements for temperature, torque, and speed requirements, and as shown on the drawings.

Standard solenoid brakes of the same manufacture as the motors shall be placed on each motor shaft and arranged so that the brakes will hold off while the current is on and apply automatically when the current is cut off the solenoid.

68. CONTROLLERS AND RESISTANCES.

For each movable span there shall be one master controller located in the operator's house, capable of governing one or both of the operating motors. Each master controller shall be of the magnet control series—parallel type with five steps and shall be so arranged and wired that the solenoid brakes on the armature shafts of the motors will be released on the first point of the controller and the motors started on the second point of the controller. Suitable resistances shall be furnished so that all motors can be started and operated from stand-still to full speed without causing injurious sparking at the commutators of the motors and without shock or jar to the bridge. All resistances shall be

mounted so as to be free from injurious vibration and so as to have free ventilation. Controllers and resistances furnished must be of ample capacity to operate and control the motors to the satisfaction of the Engineers.

For the swing span there shall be a similar controller and resistances for operating the end toggles.

69. SWITCHBOARD AND APPURTENANCES.

Switchboards shall be of first quality slate, so large that all meters, switches, cut-outs, fuses, etc., thereon may be safely and easily reached and operated by the bridge operator. Every switch, cut-out, button, etc., shall have a suitable name plate and shall be properly labeled in accordance with its purpose and use.

The switchboard shall be mounted on a substantial iron support braced to the wall.

Switches of the quick break, railway type shall be provided for each feeder and for each motor circuit.

An automatic circuit breaker equal to the laminated type ITE standard switchboard type shall be placed on the motor circuit between the feeders and the switchboard devices. Each cable, each line of motors, and each line of lighting, signal, indicator, or other circuit shall be protected by suitable fuses of a pattern approved by the Engineers. An ammeter and a volt meter made by the Weston Electrical Instrument Company, or equivalent meters acceptable to the Engineers, and of the capacity called for on the drawings, shall be furnished and mounted on the switchboard. All switchboard appurtenances necessary for the satisfactory operation of the electrical apparatus and for the complete operation of the span shall be furnished whether specifically mentioned or not, and bidders will submit with their tenders a complete statement of the appurtenances included. One set of extra carbons for each kind of circuit breaker and ten extra fuses of each kind used shall be furnished with the switchboard equipment. All switches, circuit breakers and other appurtenances shall have ample capacity for the maximum current the motors may use.

70. ELECTRIC WIRING.

All wiring from a source of supply not more than 100 feet distant from one end of the movable span shall be furnished and placed by the Contractor. Direct current at about 600 volts is available.

All wiring shall be double-braided, rubber-covered, copper wire and shall be drawn into place into loricated pipe conduits without injury to the wire or its insulation. No wires smaller than No. 12 B&S gauge shall be used.

The conductors for the swing span shall consist of steel-armored, subaqueous cables with the two independent conductors, one for the supply and one for the return current. Each cable shall be of sufficient capacity to carry safely the necessary current to operate the bridge with full overload on the motor as specified. Each cable shall be composed of nineteen strands of tinned, copper wire of not less than ninety-eight per cent conductivity. The insulating wall of rubber shall be not less than five thirty-seconds of an inch thick, containing not less than thirty per cent of pure Para rubber. There shall be one winding of tape, and a lead sheath, three thirty-seconds of an inch thick, containing three per cent of tin alloy; also a substantial jute and asphalt covering and an armor of galvanized steel wire of suitable size for the diameter of the cable. The cables shall show at sixty degree Fahrenheit an insulating resistance of five hundred megohms per mile after five minutes' electrification. These cables shall be brought up through the center pivot, as shown, with collector rings to carry the current to the controlling apparatus while the bridge is swinging. These collector rings shall be protected by movable metallic casing.

All feed wires shall be of ample capacity to carry the necessary current with a drop in potential not to exceed three per cent. Each feeder shall be protected by a pole switch, fuse and lightning arrester mounted on a non-combustible and non-absorbent insulating base.

The subaqueous cables shall be carried across the channel from the fixed span to the pivot pier, in a trench to be excavated in the riverbed not less than five feet deep and filled up after the cable is placed.

Feeders and suitable collectors, as shown by the drawings, shall be installed on the tower and on the lift span with adequate wiring and connections to the controllers.

Proper return circuits shall be provided to carry current from movable spans to the ground circuit.

71. LIMIT SWITCH.

A geared limit switch, as shown on the drawings, shall be so wired in connection with a main line solenoid located on the switchboard, that the solenoid circuit can be broken and the current cut off the motors at any point in the movement of the lift span. The solenoid shall be equipped with blow-out magnets to disrupt the arc caused by the opening of the motor circuit.

A push button switch shall be attached to the lever of the hand brake which will enable the operator to short-circuit the limit switch and thus keep current through the motor and solenoid brake until the span is closed.

72. SIGNAL LIGHTS AND SERVICE LIGHTS.

Signal lights, as required by the U. S. Government, shall be provided and placed on the piers and movable spans.

For the lift span, the following lights shall be furnished:

At each end of each tower pier there shall be one red light placed near the top of the pier. Vessel signal lamps shall be attached to the lower chords on both up and down stream sides of the lift span, each signal consisting of a double electric lantern having eight-inch Fresnel lenses colored green and red. They shall be wired so as to be controlled from the operator's stand to show either green or red, and there shall be provided in the operator's house a green and a red lamp so mounted as to denote which circuit is glowing.

For the swing span, the following lights shall be furnished: At each end of the draw protection, at each end of each side pier, and at each side of the pivot pier, there shall be one red light placed near the top of the pier. Three signal lamps shall be placed on the top of the truss span, one at each end over the portal and one on the top of the central tower, each signal consisting of a double electric lantern having eight-inch Fresnel lenses colored green and red. They shall be wired so as to be controlled from the operator's stand to show either green or red and a green and a red lamp so mounted as to denote which circuit is glowing shall be provided in the operator's house.

All lights, both red and green, shall be visible on a dark night with a clear atmosphere not less than 2,000 yards. All lights are to be shown from half round, pressed Fresnel lenses eight inches in diameter with an arc of illumination of one hundred and eighty degrees. The lamps are to be enclosed in substantial metal lanterns, firmly attached as may be approved. Pier lights on piers at the sides of the channel shall be controlled from the gate tender's houses.

There shall be placed in each machinery or operator's house ten 16 c. p. lights disposed about the room as may be directed, and there shall be placed ten 16 c. p. lights distributed amongst the outside machinery and at stair landings, as may be directed, lights on stairs to be controlled by switch at foot of stairs.

In each gate tender's house there shall be placed two 16 c. p. lights, and on each of the four roadway gates there shall be placed five 16 c. p. lights with red globes. Lights placed outside shall have weatherproof sockets. Each set of lights shall be controlled by proper switches on adequate switchboard.

All lamps, globes, sockets, wires, cut-outs, conduits, and other appurtenances necessary for the complete operation of the signal and service lights shall be provided. The wiring shall be run in approved loricated pipe conduits and the conduits shall be securely fastened to the structure. All wires shall be double-braided, rubber covered copper wire, none of which shall be smaller than a No. 12 B&S gauge and shall be drawn into the conduits without injury to the wire or its insulation, and all joints in the wire shall bo cleaned, soldered, and double-taped with friction tape.

A source of supply shall be furnished within 100 feet of each end of the movable span, and from these sources of supply the Contractor will furnish all wiring and appurtenances as described for all signal and service lights.

All signal and service lights are to be on the power circuit, or on the street railway circuits.

73. SIGNAL BELLS.

On each movable span there shall be applied and attached to the bracing over the roadway a bell for signaling to the traffic on the bridge. This bell shall consist of a twenty-one inch diameter hanging bell-metal bell with swinging clapper, which shall be connected by suitable bell rope to some convenient position in the operator's house.

74. OPERATORS' HOUSES AND GATE TENDERS' HOUSES.

All materials and workmanship in the houses and platforms and runways shall be of the best quality. Lumber shall be of best grade seasoned material. Mill work shall be of good quality, neatly joined and finished. Windows shall be provided with proper catches and with DS glass or wired glass where specified. Doors shall be of first-class mitered construction, one and three-quarters inches thick, provided with satisfactory hinges and locks. Adequate gutters and down-spouts of galvanized iron shall be provided. There shall be an approved terra cotta flue and chimney for six-inch pipe, properly placed and supported, and a stove and piping shall be furnished and set up in each house. Enclosed or covered structural steel in houses not in contact with mortar shall receive the full specified painting before being covered. Uncovered woodwork of houses, within and without, shall be painted with filler and three coats of first-class house paint to be selected by the Engineers.

The walls are to consist of Portland cement plaster placed on metal lathing. The lathing may consist of four-rib No. 26 gauge Hybrid lath or other lath and studding which may be approved, fastened to a steel frame. The outsides of the walls are to be plastered with three coats of plaster, the first two to be composed of one part fibre Portland cement and two parts of sand, and the last of one part Portland cement and two parts of sand, tempered with lime putty and finished with a stippled or a spatter-dash surface. The inside of the walls and ceiling are to be plastered with two coats of a good quality, hard wall cement plaster. The roof shall be of construction similar to the walls; two coats of plaster, the same as the first two coats for the walls, being placed on the upper side and one coat of plaster placed on the lower side of the roof lathing. The total thickness of the walls and of the roof shall be not less than one and one-half inches and not more than one and three-fourths inches.

The roofs of the houses shall be covered with asbestos shingles of dimensions as shown on the drawings. Ridges and rolls of galvanized steel of No. 19 gauge shall be supplied. In the houses on the movable span there shall be furnished a small work bench equipped with a vise, with oilers, oil can, and oil tank; and shelves shall be built as may be directed.

75. STAIRWAYS, RUNWAYS AND PLATFORMS.

The Contractor for Erection shall furnish all materials except structural metal, and shall build complete all runways and platforms, painting all woodwork with filler and two coats of paint. The steel stair treads shall be filled with cement mortar, the cost of which shall be included in the amounts paid for the erection of steel.

76. DEPTHS OF FOUNDATIONS.

All cribs, footings, caissons, and foundation bases are to be sunk or built to the depths as shown on the plans, or to such other depth as the Engineers may deem necessary as the work progresses.

The data furnished by the Engineers' drawings regarding the depths of foundations or the character and depths of the various strata of materials are to be considered merely approximate and bidders must assume the risk of having to go to a greater or less depth without changing their prices.

The data regarding the borings are not guaranteed as accurate by the Purchaser nor is the Purchaser responsible for the Contractor's interpretation of the facts disclosed by preliminary investigations.

77. EXCAVATIONS.

No special payments will be made for excavation of any kind for cribs, caissons, open pits, material from cofferdams, or any other excavation, nor for timber used in shoring,

siding, or sheeting, nor for pumping or bailing, unless specifically so stated in the contract, but the cost and value of all such excavation, shoring, pumping, etc., shall be included in the amounts paid for completed work.

No excavations shall be made outside of caissons, cribs, cofferdams, sheet piling, or sheeting, and the natural stream bed adjacent to the constructions shall not be disturbed, without the special permission of the Engineers. If any excavations or dredging is made at the sites of structures before caissons, cribs, or cofferdam constructions are sunk or placed, the Contractor shall, after the foundation base is in place, back-fill all such excavations around the caissons, crib, or similar structure to the original ground surface or riverbed, with sound material satisfactory to the Engineers, and no special payment shall be made for such work, but the value thereof shall be included in the amounts paid for foundation bases in place.

78. CONSTRUCTING AND SINKING CRIBS.

Where cribs are shown on the drawings, they shall be sunk by excavating through and loading them, or by any other method which may meet with the approval of the Engineers. Cribs shall be pumped out and filled with concrete deposited in the open if the Engineers consider that practicable; otherwise concrete shall be deposited under water to such depth as the drawings require or as the Engineers direct, by means of a water-tight tremie or other approved equipment; and when this concrete has hardened, the crib shall be pumped out and the balance of the concrete shall be placed in the open.

The framing of timber is to be done in a substantial manner and the cribs so handled during sinking that they will maintain correct shape without warping. The calking is to be thoroughly and carefully done so as to prevent leakage.

The cribs up to the tops of bases, which enclose and form part of the bases, remain permanently in place. Removable cofferdams, at least as high as shown by the drawings, are to be built on top of the cribs, within which the pier shafts shall be built in the open, and which shall be removed upon the completion of the pier shafts. No direct payment will be allowed for these removable cofferdams, but their cost must be included in the prices for shafts and bases. The designing of the temporary bracing and stiffening of cribs and cofferdams and methods of loading shall be left to the Contractor, subject to the approval of the Engineers. All loading boxes and other extraneous loads are to be cut away and removed from the piers before they will be finally accepted.

79. COFFERDAMS AND SHEETING FOR OPEN EXCAVATION.

Where types of shoring, siding, sheeting, sheet piling, or cofferdams are not shown by the drawings, their design will be left to the Contractor, who will be held responsible for the ultimate completion of the foundations for which they are used; but the designs must be made to meet the approval of the Engineers before the work of construction is started.

Cofferdams, sheeting, or sheet piling for excavations in which water is encountered shall, if practicable, be so designed and built that the water can be pumped out of them and the footings laid in the dry; but if, in the opinion of the Engineers, this be impracticable, the construction shall be carried out by placing a portion of the concrete under water by means of a tremie or other special apparatus that may be approved by the Engineers, in amount which may be approved by the Engineers, and placing the remainder of the concrete in the open after the water has been pumped out of the excavation.

80. PILES IN FOUNDATIONS.

Piles in cribs or open pits or excavations shall preferably be driven after the cribs are sunk and the excavations completed, but they may be driven before if the Engineers approve. When piles are driven after excavations are made or cribs sunk, the material they force up into the excavation or crib shall be removed to correct elevation before placing concrete.

81. PILES AND PILE DRIVING.

All piles for foundations are to be cut from live, straight, sound timber of a quality acceptable to the Engineers. They must be free from cracks, wind-shakes, and all serious

defects; and each pile shall be so straight that at every point its center will be within one-third of its diameter at that point of a straight line between the centers of its ends.

Piles must show an even, gradual taper from end to end. The ends must be cut square; all bark must be taken off, and the branches and knots must be smoothly trimmed off, finishing the piles in a workmanlike manner. Unless otherwise specified, they must not be less than nine inches in diameter at the top, and not less than fifteen inches nor more than twenty-two inches in diameter at the butt. They must be spaced accurately according to the plans, and must be driven vertically and to the satisfaction of the Engineers. When their tops are cut off the pile heads must be level and at the elevation shown on the plans.

The Contractor shall provide a suitable and efficient piledriver for driving the piles to the depth and bearing required by the Engineers without splitting them. The piles in the foundations shall be driven by the aid of water jets, and the apparatus used therefor and the amount and the pressure of the water to be used shall meet the Engineers' approval before the work is begun. Two jets per pile shall invariably be used and each jet shall discharge not less than 900 gallons of water per minute.

Piles are to be long enough so they can be driven to the final position required by the Engineers without the use of a follower. The parts of piles cut off shall be paid for at the cost per lineal foot of the piles delivered at site as determined by the Engineers, but shall be the property of the Contractor. Piles for temporary ferry approaches, for ferry dolphins and similar construction, shall, in general, conform to the above requirements but may be seven inches in diameter at the top.

82. ENCOUNTERING OBSTACLES.

Bidders must figure on taking their chances on encountering piles, logs, boulders and other obstacles at the pier sites; and the Contractor must provide himself with all the necessary tackle and apparatus for handling the same. There will be no extra price allowed because of the difficulty experienced in sinking or driving through or in removing the said obstacles and no special payment will be made for such work.

83. BACK FILLING.

Upon the completion of any pier, pedestal, abutment, or wall, the surrounding space shall be backfilled to the original ground surface with earth properly compacted in a manner that will prevent unsightly depressions. Where necessary to prevent settlement, the earth in back filling shall be rammed in layers not exceeding six inches in thickness, or water tamped in layers not exceeding two feet, depending upon the character of the material.

84. RIP-RAP AND MATTRESSES FOR PIERS.

There shall be placed around the piers, as may be directed, either a quantity of rip-rap material or willow mattresses anchored by stone.

Stone used for rip-rapping piers must weigh, when dry, at least 140 pounds per cubic foot, must be hard, firm and durable, and must not disintegrate in water or in air. The blocks of stone must be angular and as nearly cubical as possible. Not more than one-fourth may be in pieces weighing less than one thousand pounds each, at least one-fourth must be in pieces weighing at least two thousand pounds each, and the balance will be in pieces weighing from one thousand pounds to two thousand pounds. Pieces weighing less than fifty pounds will not be accepted. The above proportion of sizes of stone will be required to be deposited in each pile or area as may be required. Stone dumped contrary to directions no matter where, will be considered wasted, and will not be paid for. Stone will be paid for by the cubic yard of solid material, no allowance being made for voids. The volume of solid material will be determined by its weight as found by scales, or by displacement measurement, if delivered in barges, and by the average specific gravity as may be determined from time to time.

If the Contractor so elects, artificial stones made of concrete will be accepted for rip-rap. The concrete shall be in proportion one part Portland cement, five parts sand, and ten parts gravel, the ingredients and the mixing to be of the character specified under the clauses on concrete.

If willow mattresses are used, they shall be of the sizes required and twelve inches thick. They shall be constructed around the finished pier and woven in one continuous mat for each pier. Mattresses shall be woven out of good, live, bar-growth willows, freshly cut, one-half to two inches in diameter at the butt by five to twenty-five feet long. These shall be woven in stitches about one foot wide over and under, with a selvage woven along each end and side and along the sides and ends of the opening in the mat for the pier base. There shall be galvanized wire cables three-eighths inch in diameter composed of seven No. 11 wires and having an ultimate strength of five thousand pounds, run longitudinally and transversely, both above and below the mat not more than ten feet between centers; full length and width of the mat, and one similar cable one-half inch in diameter shall be woven into each selvage, to which the smaller cables shall be attached. At the intersection of all longitudinal and transverse cables the lower two cables shall be fastened to the upper two cables with suitable and satisfactory iron clips not less than five-eighths inch in diameter, or instead of clips, a piece of cable properly attached and fastened so as to hold the cables securely in place may be used. These clips or fastenings are to be placed and thoroughly secured and fastened after all slack shall have been taken up in the cables by block and tackle.

There shall be used not less than one cord of brush to every 150 square feet of mattress. The brush shall be measured before weaving is started.

Each mattress shall be sunk in place and ballasted with not less than one cubic yard of one man stone, or more if necessary, to every 100 square feet of mattress. The stone shall be evenly and uniformly distributed, and the mattress shall be placed into good contact with the riverbed. Before any mattress is sunk, the area it will occupy is to be cleared of projecting logs, snags, or piles.

If the piers are rip-rapped, there probably will be used for the Columbia River bridge from 1,000 to 1,500 cubic yards per pier, and for the Oregon and Columbia Slough piers, from 700 to 1,000 cubic yards per pier; but the amount may be greater or less.

If mattresses are used, they probably will be 125 feet wide and 200 feet long up and down stream for the Columbia River piers; and 100 feet wide and 150 feet long for the Oregon and Columbia Slough piers.

85. TIMBER.

Timber and lumber shall be sound, sawed to standard size, square-edged and straight; free from defects, such as injurious ring shakes and cross grains, unsound or loose knots, knots in groups, decay, or other defects that will materially impair its strength or durability. Except when used under water, not more than fifteen per cent of any cross sectional area of any timber shall be sap-wood. Timber remaining permanently under water shall be first-class, square-edged and sound. All timber and lumber shall be surfaced on four sides to standard dimensions.

In paying for timber, only the actual net lengths remaining in the structure will be allowed for, but other dimensions than the lengths will be taken to accord with standard sizes.

All timber left in the structure above low water shall be long-leaf, yellow pine, Oregon fir, or mountain pine, while timber left permanently below low water may be of any variety which, in the opinion of the Engineers, is suitable and of adequate strength.

86. TIMBER CONSTRUCTION.

The framing of all timber is to be done well and carefully by skilled carpenters, with neat joining and tight fitting throughout; and all timber work shall be done in the most substantial and thorough manner practicable. Ample numbers of fastenings, as called for on the drawings, or as may be required by the Engineer, are to be used so as to properly connect all parts. Malleable iron washers are to be used under all heads or nuts of bolts bearing on wood. They are to be of sufficient size to distribute properly the greatest allowable tension in the bolts. Bolts for timber constructions are to be of rivet steel and are to have square or hexagonal heads and nuts and U. S. standard threads.

87. CREOSOTING.

Creosoted timber and piles of Oregon fir or mountain pine shall be treated so as to receive and contain ten pounds of creosote oil per cubic foot of timber. Wherever prac-

ticable all timber treated shall be cut to exact dimensions before being treated so that it will fit into position without trimming at the site. When creosoted timber is cut into or trimmed after treatment, such surfaces shall be painted with creosote oil.

The oil shall be the best obtainable grade of coal-tar creosote; that is, it shall be a pure product obtained from coal gas or coke oven tar, and shall be free from any tar, oil or residue obtained from petroleum or any other source, including coal gas tar or coke oven tar; it shall be completely liquid at thirty-eight degrees centigrade and shall be free from suspended matter; the specific gravity of the oil at thirty-eight degrees centigrade shall be at least 1.03. When distilled by the common method—that is, using an eight ounce retort, asbestos covered, with standard thermometer, bulb one-half inch above the surface of the oil—the creosote, calculated on the basis of the dry oil, shall give no distillate below two hundred degrees centigrade, not more than five per cent below two hundred and ten degrees centigrade, nor more than twenty-five per cent below two hundred and thirty-five degrees centigrade, and the residue above three hundred and fifty-five degrees centigrade, if it exceeds five per cent in quantity, shall be soft. The oil shall not contain more than three per cent of water.

The process of treatment shall be such that the oil is injected into the wood at proper temperature, and the exact process to be used shall be approvd by the Engineers before creosoting begins.

88. BROKEN STONE OR GRAVEL.

Where not otherwise specified, either broken stone or clean, hard gravel of qualities satisfactory to the Engineers may be used in making concrete. The broken stone shall consist of pieces of hard and durable rock such as trap, limestone, granite, or conglomerate, which shall be free from dust, clay, loam, or other material in such amounts as will, in the opinion of the Engineers, impair the concrete. The stone shall be crusher run up to the sizes specified, with all material that will pass a one-quarter inch screen removed.

The gravel shall be composed of clean, hard pebbles screened to the specified sizes, being crushed where necessary, free from clay, loam, or other material in such amounts that will, in the opinion of the Engineers, impair the concrete. Material that will pass a one-quarter inch screen must be taken out.

If not satisfactorily clean, materials may be used if they are washed or otherwise cleaned to satisfactory condition. Stone or gravel shall be stored on board platforms and must not be shoveled up from the ground.

89. SAND.

Sand shall be defined as particles of hard, clean, stone, which shall pass a sieve of one-quarter inch square mesh, and not less than fifty per cent of which shall be retained upon a sieve of twenty-two thousandths of an inch square mesh, or what is commonly called a No. 30 sieve.

90. CEMENT.

Bonner Portland Cement conforming to the following requirements shall be used, provided the same can be purchased for the same price as other cements fulfilling the requirements.

Cement shall be Portland cement of quality equal in every respect to the best brands of American manufacture, delivered at site in suitable packages, satisfactory to the Engineers, so as to be reasonably secure from air and moisture. Each package shall be labeled with the name of the brand, the place made, and the name of the manufacturer.

The cement shall be ground so fine that it shall leave by weight a residue of not more than eight per cent on the No. 100, and not more than twenty-five per cent on the No. 200 sieve.

The cement shall not develop initial set in less than thirty minutes, and shall not develop hard set in less than three hours nor in more than ten hours. The times of setting shall be as determined by a Vicat apparatus.

Neat cement shall be molded on glass into pats having thin edges and kept in moist air for 24 hours. These pats shall then be immersed three hours in boiling water, and then steamed three hours in a closed vessel. At the conclusion of these tests the pats

must be sound and hard and true to their original shape. If they are warped, soft, or disintegrated, the cement from which the samples were taken will be rejected.

The minimum requirements for tensile strength for briquettes one square inch in cross section shall be as follows, and the cement shall show no retrogression in strength within the periods specified:

For neat cement:

Twenty-four hours in moist air, strength 175 pounds.

One day in moist air, 6 days in water, strength 500 pounds.

One day in moist air, 27 days in water, strength 600 pounds.

For one part cement, three parts sand by weight:

One day in moist air, 6 days in water, strength 200 pounds.

One day in moist air, 27 days in water, strength 275 pounds.

In every case the cement to be used shall be approved by the Engineers before being used.

Any cement that is caked or otherwise damaged so as, in the opinion of the Engineers, to be injured, shall be rejected and all rejected cement shall be removed immediately from the vicinity of the site.

The Contractor shall provide a suitable building for storing the cement, in which the same shall be so stored as to permit easy access for proper inspection of each shipment.

The Engineers shall be notified of the receipt of cement for testing at least two weeks before it is required for use.

91. CONCRETE PROPORTIONS.

Concrete for the various portions of the structure shall be made of cement; clean, coarse, sharp sand; and broken stone or gravel, as specified above, mixed in the following proportions:

A. Concrete not otherwise specified, one part cement, three parts sand, five parts stone or gravel which will pass through an iron ring two and one-half inches in diameter.

B. Concrete for copings and for tops of construction sustaining loads; concrete for handrails and ornamental posts at end of Columbia River bridge; concrete slabs on steel structures, except where otherwise specified, one part cement, two parts sand, four parts stone or gravel which will pass through an iron ring one and one-fourth inches in diameter.

C. Concrete that is deposited through water, one part cement, two parts sand, and four parts stone or gravel that will pass an iron ring one and one-quarter inches in diameter.

D. Concrete for slope protection slabs on embankments, one part cement, three parts sand, five parts gravel which will pass through an iron ring one and one-quarter inches in diameter.

E. Concrete for the rail headings on the steel structures, comprising about seven inches of which on each side of each rail; one part cement, two parts sand, four parts of broken pieces of hard, dark colored basaltic rock, or equally hard stone which will pass through an iron ring one and one-quarter inches in diameter.

92. MEASUREMENTS OF STONE, SAND AND CEMENT.

The amounts of all the ingredients of concrete shall be determined by volume and measurements are to be made loose. One barrel of cement, weighing 376 pounds net, shall be considered to measure four cubic feet, or one bag of cement weighing 94 pounds net, shall be considered to measure one cubic foot. The sand and the broken stone or gravel shall be accurately measured by delivering to wheelbarrows or to the mixers through boxes or compartments of known volume. The method of measuring the ingredients of the concrete and the quantity of water used shall be subject to the approval of the Engineers.

93. MIXING AND PLACING CONCRETE.

All concrete shall be mixed in a mechanical batch mixer of a type which shall be approved by the Engineers, except where special permission is given to mix by hand. Continuous mixers shall not be employed on the work. The machine shall be operated long enough after the last ingredient is deposited in it thoroughly to mix and incorporate all ingredients to the satisfaction of the Engineers. Clean water, free from oil, acids, strong alkalies, or vegetable matter, shall be used in mixing concrete. The water shall be added in such quantities as will produce a wet mixture such as will flow readily in the forms and around timbers or reinforcing bars, but the concrete shall not be so wet as to cause the aggregate to separate from the mortar.

When concrete is mixed by hand, the mixture of sand and broken stone or gravel is first to be spread in a thin layer on a timber platform, then the cement is to be spread on top thereof, then the mass is to be mixed thoroughly while dry, after which the proper quantity of clean water is to be added gradually while the mass is being turned over and mixed until the mortar thus formed covers the pieces of broken stone or gravel entirely and until the concrete attains the proper consistency.

Immediately after mixing, concrete shall be conveyed to place in such manner that there shall be no separation of the different ingredients. Except as otherwise permitted, it shall be deposited so as to bring the construction upward about level; and shall be rammed, spaded, and agitated by suitable tools as may be directed, so as to produce a thoroughly compact concrete of maximum density; and so that all interstices are filled, and so that the concrete will present a smooth, finished, unbroken mortar surface without exposed stone, when the forms are removed. Should any concrete receive its initial set before being placed it shall be rejected and removed from the site of the work immediately. If so directed by the Engineers, concrete in long columns or in deep, narrow walls shall be placed through a tremie.

The Contractor shall so conduct his work that where necessary in the opinion of the Engineers, the placing of concrete for any integral part of the structure shall be continuous; and in all cases the placing of concrete shall be stopped only at such points as the Engineers may approve. The Contractor shall not begin to place concrete for any such integral portion of the structure until the Engineers are assured that adequate quantities of the materials, which have been inspected and accepted are available to construct said portion of the work without interruption. Before placing fresh concrete, all shavings, sawdust, and debris of every nature must be removed and the old concrete surface thoroughly cleaned of all dirt and scum or laitance and drenched with water.

Should, during construction, any surfaces of concrete be allowed to harden or dry before the other concrete is placed thereon, they shall be swept perfectly clean with brooms, then washed thoroughly with clean water, and the skin coat scraped away for a strip about six inches wide next the forms and this shall be brushed with wet mortar of the proportions in the concrete, and the junction of old and new work made neat without open joints or offsets. The forming of such dry surfaces, however, shall always be avoided if practicable.

If any imperfections shall be found upon the exposed surfaces of concrete, when the forms are removed the imperfection shall be immediately corrected in a manner satisfactory to the Engineers; notwithstanding that the Contractor had been permitted to proceed with certain forms and methods of placing concrete.

Except as otherwise specified, the Contractor for concrete construction will be required to build in place accurately all metal that is imbedded or anchored in the concrete.

All concrete deposited under water shall preferably be deposited by means of a watertight tremie held vertically and arranged to be lifted and lowered as desired, but buckets which open at the bottom and which are tripped by contact with the bottom may be used if the Engineers approve. Buckets tripped by a line operated from above shall not be used. Buckets shall be as large as practicable.

No concrete shall be made or placed in freezing weather unless by and in accordance with the directions of the Engineers.

After the concrete composing the sidewalk slab is placed, and before the concrete has set the mortar shall be worked to the surface, and the surface troweled and finished with a float so as to give a smooth and uniform surface.

The upper surface of the concrete under pavement shall conform accurately to crown and grades and shall not be in waves that vary from a true surface more than one-quarter inch in a distance of ten feet, and shall provide, except where otherwise required,

a smooth even mortar finish. The curbs shall be troweled to a smooth finish, if possible, without other mortar than that contained in the concrete. Drainage castings shall be accurately set and slabs and curbs shall be neatly finished around them.

The concrete for the rail headings shall be placed after the other concrete in the roadway slab has thoroughly set. This concrete must be thoroughly compacted into place, so as to be dense and hard, and the spaces for wheel flanges must be formed accurately to the dimensions shown on the drawings, and there must be no large aggregate exposed on the surfaces. The Contractor may compact the concrete by compressing with a roller of satisfactory weight, or by some method that will be satisfactory to the Engineers; and methods will be altered or varied so as to produce the desired results.

94. ORNAMENTAL CONCRETE COLUMNS AND CONCRETE HANDRAILS.

At the Vancouver end of the structure, there will be constructed two ornamental concrete columns and two portions of concrete handrails as shown by the plans. Particular attention is to be given to the surface finish of the concrete, and it must be of even texture and uniform color, and must not show any board marks of forms. It shall be finished by rubbing with a carborundum brick, by bush hammering, or by other means which may be approved by the Engineers. The metal name plates which are to be placed upon the columns will be furnished by another Contractor and placed by this Contractor.

95. FORMS, STAGING AND FALSEWORK.

The Contractor shall build all falsework and staging of adequate strength to support safely the loads imposed upon them without injurious deformation or settlement.

The Contractor shall provide suitable forms, and their design shall be adapted to the structure and to the kind of surface required on the concrete. The forms for concrete surfaces which will be exposed to view shall be made of lumber which is dressed on both edges and on the faces next to concrete, and the pieces shall be straight so as to insure a tight form that will prevent the leakage of mortar. Forms shall be substantially built and supported in such manner as to prevent bulging or deformation from the weight or ramming of the concrete. All exposed corners and edges of concrete constructions are to be rounded off to a two-inch radius, unless specifically called for otherwise on the drawings.

Before the removal of forms, the concrete shall have attained a strength which in the opinion of the Engineers, will prevent injury from such removal. Falsework shall be maintained under all constructions until such time that the concrete is able to sustain itself and any load that is likely to come upon it, with absolute safety to the concrete.

In all cases the Contractor is responsible for and must make good any injury arising from inadequate forms or falsework, or from the premature removal of same.

96. PREPARING AND PLACING REINFORCEMENT.

The reinforcement in the finished structure shall accurately conform in size and position to the requirement of the plans. Before being placed in concrete, all reinforcement shall be free from loose rust, scale or coating of any kind, which will reduce the bond between it and the concrete. All reinforcing bars shall be bent cold to the dimensions and forms shown on the drawings before they are placed in position. The bends shall be accurately made in a bending machine.

Reinforcing bars and other reinforcement shall be placed accurately in position shown for them on the drawings and shall be firmly held there during deposition of concrete by fastening the bars at crossings and splices and by the use of bars or other suitable spacers and by special fastenings when any are shown on drawings. Adjustment of bars during the placing of concrete will not be permitted. Where necessary, small blocks made of cement mortar may be used to support the reinforcing rods at proper distances from the forms.

The reinforcement for the roadway slabs is designed to be placed directly on the roadway cross beams and other structural parts.

97. EMBANKMENTS AND EARTHWORK.

Enbankments are to be constructed on and about certain streets in the City of Vancouver, across Hayden Island, from the Oregon Slough to the Columbia Slough and from

the Columbia Slough to a point near the Columbia Boulevard. These embankments shall fill behind and around the buried piers. There may be included certain roadway cross-over and some fill on Columbia Boulevard.

The materials used for the embankments shall be sand, gravel, clay, loam, or other earthy material free from pieces of wood, roots, or other foreign substances. Light, silty material must not be used. If the embankments are constructed of sand, gravel, or other material that compacts readily, it may be dumped in such manner as is best suited to the Contractor's scheme of construction, but if clay or clayey material is used, it shall be deposited in horizontal layers over the entire width of the embankment. If the material is deposited in layers, the layers must be as thin as dumping from wagons will conveniently permit. The shoulders and side slopes of embankment must be straight, neatly formed and regular, and shall conform to the slope stakes. It is expected that most of the embankment will be made from sand dredged from the river, but the Contractor may get the material from any source except that borrow pits must not be closer than twenty feet from the toe of embankment slopes.

There shall be placed on all embankments sufficient additional material to provide for shrinkage and for subsidence of the supporting ground so that on July 31, 1916, the embankments shall be not less than the required elevation, width on top, and side slopes for the net embankments shown by the drawings. If at the end of this period the embankments do not correctly conform to grade and slopes, the Contractor shall place such additional material as will bring them to the correct elevations and dimensions.

It is considered possible that the land may subside under the embankment over parts of Hayden Island, and over parts of the line between Oregon Slough and Columbia Boulevard, but it is not possible to estimate the amount of such subsidence, if any, nor the amount of additional material required to be placed in the embankments on account of it. Bidders are especially urged to examine this ground and to investigate experiences in making similar embankments in this neighborhood.

Payment for embankments will be made at a price per cubic yard of volume included between the present existing ground surface and the required top elevations and the required net side slopes. No payment will be made for extra material necessary for shrinkage, or for material placed on account of subsidence of land, or for any other material additional to or in excess of the above described volume, but the value and cost of all such material shall be included in the amounts paid for the volume as described. Before the embankment is begun the existing ground surface will be cross-sectioned by the Engineers and made of record and the surface from which the volume is calculated shall be that shown by these data.

The Contractor for constructing the embankments shall cut away and remove all trees, brush, logs, and debris from the site of the embankment. Trees shall be cut off not higher than two feet from the ground surface. With the exception of the area on Hayden Island, there is little clearing to be done. The cost and value of all the clearing that is done shall be covered by the amounts paid per cubic yard for the embankment.

98. ROCK FILLS.

At the bottom of the slopes of the embankments at certain buried piers as shown by the drawings there will be built loose rock fills, of stone generally conforming in character to that specified for rip-rap for piers, but in sizes from 100 pounds to five hundred pounds per piece. These rock fills will be made before the earth embankment above them is placed, and their surface considered "present ground surface" in figuring earth embankments. The rock fills will be paid for at a price per cubic yard measured as described for rip-rap for piers.

99. CONCRETE SLOPE PROTECTION ON EMBANKMENTS.

The concrete slope protection as shown by the drawings shall be constructed not sooner than nine months after the completion of the portion of the embankment they cover. Before placing the concrete slab, the slopes shall be neatly trimmed to surface and slope, exactly to conform to the required slope line, and the concrete shall be placed thereon as soon after the forming of the slope as may be reasonably possible. The concrete slabs shall be four inches thick and in continuous slabs extending up and down the slope for the full height required, and shall be in width not exceeding eight feet measured

longititudinally on the embankment. The reinforcement shall be properly placed and the tops of the slabs shall be screened off and brought to correct elevation and the mortar of the concrete worked to the face so that large aggregate will not appear. The lower edge of the slab at the toe of the embankments shall be built in a ditch to be excavated below the original ground surface as shown by the drawings, or as may be required, and after the concrete is placed therein, the ditch shall be filled.

The Contractor for the construction of the embankment will be required to finish the slopes of the embankments and dress them to a reasonable finish, but it is not expected that such finish will leave the slopes in proper condition to receive the concrete slab. The Contractor for placing the concrete slabs, will, therefore, refinish the slopes where slabs are placed to give the exact surface as described; and the price to be paid for the concrete slabs in place shall include and cover all of the work of resurfacing the slopes and of excavating and backfilling the ditch at the toe-wall for the slabs.

100. PAVEMENT ON STEEL STRUCTURES.

A pavement consisting of sheet asphalt, of asphaltic concrete, or of bitulithic concrete, and conforming to the following specifications shall be placed on the top of the concrete slab on the steel structure, in thickness and area as shown on the drawings.

The asphalt employed in the preparation of asphaltic cement for asphalt paving shall be refined so as to be in every respect uniform in composition and of the character set forth in the specifications. At least ninety-nine per cent by weight shall be soluble in carbon bisulphide or chloroform, and at least 98.5 per cent shall be soluble in carbon tetrachloride, and as far as possible, it shall be free from foreign and organic matter and volatile oils. The penetration of the refined asphalt shall be not less than fifty-five degrees Dow. A sample weighing 20 grams heated in an oven for five consecutive hours at a temperature of 325 degrees F. shall show a loss of not more than 3 per cent by weight. With every lot or shipment of asphalt, or asphaltic flux, the Contractor shall submit to the Engineers a statement setting forth the name of the company supplying the material, the name of the refinery at which the asphalt was prepared, with a report of the tests made. Every barrel or container shall have marked upon it a number indicating the batch or run referred to in the reports of tests.

The oil used in the manufacture of asphaltic cement shall be a petroleum from which the lighter oils have been removed by distillation. It shall be free from coke and other impurities and shall have a specific gravity of from nine to twelve and nine-tenth degrees Beaume; shall stand a fire test of 450 degrees F., and shall contain not more than 10% by weight of paraffin. The flux or petroleum substituted shall be a residue from the distillation of California or other suitable petroleum. It shall be soluble in carbon bisulphide not less than 90%, and soluble in 86 degrees naptha not less than 90%. It shall be free from water, and shall lose by volatilization not more than 5% of oil when subjected to a temperature of 325 degrees F., for seven consecutive hours. It shall yield not more than six per cent fixed carbon on ignition, and when examined under a microscope beneath a covered glass, shall appear free from insoluble or suspended matter.

The asphaltic cement shall be a mixture of refined liquid asphalt with a refined solid asphalt, or be an oil asphalt and shall be free from admixture with any residue obtained by the artificial distillation of coal, coal tar, or paraffin oil. It shall be homegenous in composition and shall have a consistency such that penetration with a No. 2 needle weighted to 100 grams for five seconds and at a standard temperature of 77 degrees F. shall be not less than 65 degrees nor more than 80 degrees Dow. While in use the asphaltic cement shall be thoroughly agitated.

The sand used in asphaltic mixtures shall be clean, hard-grained and moderately sharp, and shall not contain more than 2% of loam, clay, or other objectionable material; all of it shall pass a 10-mesh screen and when ready to be incorporated with the asphaltic cement, shall contain not more than four per cent of material passing a 200-mesh screen.

A. The Sheet Asphalt Pavement shall consist of a wearing course laid immediately upon the concrete slab of the roadway in such manner that the minimum thickness measured at any point after the asphalt has received its final rolling, shall be not less than two inches. This wearing course shall be composed of a mixture of sand, filler, and asphaltic cement in the following proportions by weight:

Aggregate passing 10-mesh screen retained on 20-mesh screen, 2 to 5%.

Aggregate passing 20-mesh screen retained on 30-mesh screen, 4 to 18%.

Aggregate passing 30-mesh screen and retained on 50-mesh screen, 18 to 24%.

Aggregate passing 50-mesh screen and retained on 80-mesh screen, 20 to 26%.

Aggregate passing 80-mesh screen and retained on 200-mesh screen, 24 to 32%.

Aggregate passing 200-mesh screen, 11 to 16%.

Asphaltic cement, 11 to 13%.

At least 10% and not more than 16% of the mixture shall be Portland cement filler.

B. The Asphaltic Concrete Pavement shall consist of a wearing course laid immediately upon the concrete slab of the roadway in such manner that the minimum thickness measured at any point after the asphalt has received its final rolling shall be not less than 2 inches. This wearing course shall be composed of a mixture of sand, filler, broken stone, and asphaltic cement in the following proportions by weight:

Aggregate passing one-half inch screen, retained on one-fourth inch screen, 5 to 9%.

Aggregate passing one-fourth inch screen, retained on 10-mesh screen, 27 to 31%.

Aggregate passing 10-mesh screen, retained on 40-mesh screen, 13 to 17%.

Aggregate passing 40-mesh screen, and retained on 200-mesh screen, 28 to 33%.

Aggregate passing 200-mesh screen, 6 to 10%.

Asphaltic cement, 9 to 12%.

After the broken stone and sand shall have been heated in a mechanical rotary drier to a temperature between 250 and 325 degrees F., the whole mass shall be passed through a rotary screen having circular openings of a maximum diameter of one-half inch and a minimum diameter of one-tenth inch. The materials thus separated shall pass into separate bins or compartments from which they shall be separately drawn into the weigh-box in the proportion specified. If the proper proportion of filler be not obtained from the crushed rock, the deficiency shall be supplied by addition of Portland cement or pulverized stone of approved quality.

C. The Bitulithic Concrete shall consist of a wearing surface laid immediately upon the concrete slab of the roadway in such manner that the minimum thickness measured at any point after the wearing course has received its final rolling, shall be not less than two inches. This wearing course shall consist of the following mixture in the following proportions by weight:

Aggregate passing one-inch screen and retained on one-half inch screen, 36 to 50%.

Aggregate passing one-inch screen and retained on one-fourth inch screen, 12 to 20%.

Aggregate passing one-fourth inch screen and retained on 10-mesh screen, 8 to 12%.

Aggregate passing 10-mesh screen and retained on 200-mesh screen, 24 to 32%.

Aggregate passing 200-mesh screen, 4 to 7%.

Bitulithic cement, 7½ to 9½%.

From 50% to 70% of the aggregate passing a 10-mesh screen shall pass a 40-mesh screen, and from 20% to 35% of the sand shall pass an 80-mesh screen. After the broken stone and sand shall have been heated in a mechanical rotary drier to a temperature between 250 and 300 degrees F., the whole mass shall be passed through a rotary screen having circular openings of a maximum diameter 1½ inches and a minimum diameter one-tenth inch. The materials thus separated shall pass into separate compartments from which they shall be drawn separately into a weigh-box in the proportions specified. If the proper proportion of filler be not obtained from the crushed rock, the deficiency shall be supplied by the addition of Portland cement or pulverized stone of an approved quality.

The wearing course of any of the above pavements shall be prepared by determining the proper amounts of the several constituents by the use of a suitable weighing device before being dumped into the mixing box. The sand and broken stone shall be heated in a suitable contrivance to a temperature between 250 and 325 dgrees F. These hot materials and the cold filler shall be thoroughly mixed together dry in a twin-pug or other approved mechanical mixer for not less than fifteen seconds. The required quantity of asphaltic cement previously heated to between 275 and 325 degres F. shall then be added and the whole mass mixed until every particle shall be thoroughly coated with the asphaltic cement. The aphaltic cement shall never be heated to a temperature in excess of 325 degrees F. If a pug type of mixer be used, the mixing of the various materials shall con-

tinue for not less than one and one-half minutes including the dry mix with the mixer paddles rotating between 70 and 90 revolutions per minute and the mixing shall he continued until the combination is uniform and homogenous.

The mixture as prepared above shall be delivered on the work at a temperature of not less than 250 degrees and not more than 300 degrees F. and shall at once be uniformly spread with hot shovels and rakes to such a depth that after the final compression, the wearing surface shall have not less than two inches of thickness and shall be of uniform density. It shall be immediately rolled with a roller producing a compression of about 100 pounds per inch width of tire. There shall follow immediately a second rolling by a roller producing not less than 200 pounds per inch width of tire, which rolling is to be continued until no impression is made upon the surface by the roller; but in no case shall there be less than five hours rolling for each 1,000 square yards of pavement. For sheet asphalt and asphaltic concrete, a small amount of hydraulic cement shall be swept over the surface.

For a distance of two feet from the curb, the surface of the pavement shall be painted with hot, asphaltic cement to provide a seal to the concrete gutter. This paint coat shall be applied with mops or other suitable devices in a direction parallel to the curve, and care shall be taken not to mar the concrete gutter. Every portion of the surface mixture not accessible to the rollers shall be compressed by tamping and shall be smoothed with hot irons with especial care for such tamping and smoothing adjacent to and around catch basins and other surface structures. Iron rakes, shovels, tampers, and other tools must not be overheated. The cold joints between old work and new work, and all metallic surfaces in contact with the wearing surface shall be painted with hot asphaltic cement before additional wearing surface may be laid.

The finished pavement, of any class, shall show a close-grained, even, and smooth surface true to grade and crown to correct elevation and free from hollows or inequalities, and so as to give correct drainage to the gutter.

In the case of asphaltic concrete or bitulithic pavement, after the rolling above specified has been finished, a thin coating of asphaltic cement shall be uniformly spread over the entire surface completely to fill any unevenness of surface voids, and immediately thereafter a thin layer of hot stone chips shall be spread over the surface and rolled into it until thoroughly united with the wearing surface producing a solid, dense, bituminous concrete.

No binder, and no wearing surface for pavement shall be laid in rainy weather, nor shall any wearing surface be laid if the concrete slab be not thoroughly dry. The laying of wearing surface at night shall not be permitted.

101. PAVEMENT ON EMBANKMENTS.

The pavement on embankments shall be any of the pavements specified for steel structures laid upon a concrete base, or shall be Concrete Pavement No. 1, Concrete Pavement No. 2 (Hassam), or Asphaltic Concrete Pavement No. 1 on a broken stone base, or Asphaltic Concrete Pavement No. 2 (Bitulithic) on a broken stone base.

The Contractor for placing the pavement shall make such surface excavations and filling as may be necessary on the embankment to provide the proper surface at the proper grades and slopes and elevations required for placing the pavement. The surface of the embankment is to be thoroughly rolled and compacted with a roller, allowing a compression of not less than 200 pounds per inch width of tire. The cost and value of such surface excavation, filling, and rolling shall be included and covered by the price paid for the pavement in place complete. After preparing the subgrade all unnecessary traffic must be kept off.

A. Concrete Pavement No. One shall be composed of one part of cement, two parts of sand and three and one-half parts of broken stone of a hard dark-colored basaltic rock of uniform texture with sharp edges, or stone of an equal hardness having a specific gravity of not less than 2.7. Not more than five per cent of the total volume of the broken stone shall pass a screen one-quarter inch mesh, and not less than 30% of the total volume of the broken stone shall pass a screen of one inch mesh. The sizes of broken stone shall vary from the above minimum to particles passing in any direction through a two-inch ring. Where not otherwise specified, materials and the mixing and placing of the concrete are to conform to the general requirements for concrete materials and mixing and placing concrete specified above. Prepared bituminous expansion joint fillers shall be

placed in straight joints extending at right angles across the roadway every 30 feet. The filler shall be water-tight and elastic of composition that will not become brittle in cold weather or so soft as to run during hot weather. Cured joints will not be acceptable.

The entire thickness of concrete shall be laid in one course and it shall be compressed by a roller to provide a dense compact concrete or shall be thoroughly tamped or worked so as to be the equivalent of concrete produced by rolling, to the satisfaction of tha Engineers. The surface shall then be grouted with a mixture of one part Portland cement to two parts sand to completely fill any remaining voids and immediately broomed with steel wire brooms with a movement transverse to the axis of the roadway. The finished surface must be true and uniform, conforming exactly to the required grade and elevation. The transportation of concrete from the point of mixing to the point of deposit shall be conducted in such manner that the mortar will not be lost and the concrete shall be so handled that when deposited in place it shall be uniform in composition throughout, showing neither excess nor deficiency of mortar in any part of the mass. It shall be transported in water-tight containers and shall be in place within thirty minutes after discharge from the mixer. While the concrete is being placed, particular care shall be exercised to prevent disturbance of the rolled subgrade. Before any concrete may be placed upon it, the subgrade shall be thoroughly wetted.

During the summer months, beginning twenty-four hours after the pavement shall have been completed, the entire surface shall be continuously wetted with water thrown in a fine spray, or by other means satisfactory to the Engineers, for a period of at least seven days, and for the entire daylight hours of every day. For this sprinkling the Contractor shall employ at least one man for each 2,000 square yards of finished pavement, or shall use other method which may meet the approval of the Engineers. No traffic of any kind whatsoever shall be permitted upon the finished pavement until express permission is given by the Engineers. The total thickness of the pavement shall be not less than seven and one-half inches from the subgrade to the finished surface of the pavement at its thinnest point.

B. Concrete Pavement No. Two (Hassam) shall consist of broken stone, sand, and cement of qualities heretofore specified for concrete pavement except that the broken stone shall vary in size from three inches to one inch in each dimension. The stones shall be spread to a sufficient depth to bring the surface after thorough rolling to the finished grade of the street. The road roller used shall allow a compression of not less than 200 lbs. per inch width of tire and any portions of the pavement which may not be accessible to the roller shall be thoroughly compressed by tamping.

Into the stone so compacted, a grout consisting of one part of Portland cement to two parts of sand shall be poured. This grout shall be sufficiently thin to flow freely and shall be continuously mixed while being poured. Pouring shall continue until all voids are filled and the grout flushes to the surfaces under rolling by a road roller or upon compression by tamping, which shall immediately follow the grouting. The compression shall be continued until the pavement may no longer be compacted. Over the entire pavement as above prepared, a layer of pea stone shall be evenly and smoothly spread to such thickness that after a thorough tamping or compression by a road roller the voids in the surface may be filled. Upon completion of the top dressing, the surface shall be broomed as described for concrete pavements.

The finished surface must be true and uniform, conforming exactly to the required grade and elevation. The surface of the finished pavement shall be sprinkled in the same manner as described for concrete pavement and no traffic of any kind whatsoever shall be permitted upon the finished pavement until express permission is given by the Engineers. The total thickness of the pavement shall be not less than six inches from the subgrade to the finished surface of the pavement at its thinnest point.

C. For pavements upon concrete base, the base shall be composed of one part cement, three parts sand, and five parts of broken stone or gravel which will pass through an iron ring two and one-half inches diameter, conforming to the requirements for concrete of these specifications. The concrete base shall be not less than five inches thick and its surface shall be parallel to and not less than the specified thickness of pavement below the finished grade and surface of the pavement. For sheet asphalt, the total thickness of the pavement shall be two and one-half inches, of which one inch shall be a binder course. For Asphaltic Concrete Pavement No. 1 the total thickness of pavement shall be two and one-half inches, of which one inch shall be binder course. For Asphaltic Concrete Pavement No. 2 (Bitulithic), the total thickness shall be two inches. The construc-

tion of these surfaces shall conform to the foregoing specifications for pavement upon steel structure.

D. For pavements upon broken stone base, the base shall be constructed of broken stone conforming to the specifications for stone and concrete pavement, but varying in size uniformly from one and one-fourth to three inches in diameter, spread upon the rolled subgrade to such depth that when compressed with road roller having compression of not less than 200 pounds per inch width of tire, the thickness shall not be less than six inches. The laying of broken stone base more than twenty-four hours in advance of the wearing course shall not be permitted. For Asphaltic Concrete Pavement No. 1 the total thickness of the pavement shall be two and one-half inches, of which one inch shall be binder course. For Asphaltic Concrete Pavement No. 2 (Bitulithic), the total thickness shall be two inches. The construction of these surfaces shall conform to the foregoing specifications for pavement upon steel structures.

102. HANDRAILS ON EMBANKMENTS.

After the completion of the pavement on embankments, the handrails on the embankments shall be built in accordance with the plans. The materials shall conform to the general requirements of these specifications as to quality, and the handrails shall be erected and completed in correct line and in a workmanlike manner. The portions of the handrail posts to be imbedded below ground surface shall be dipped in carboleneum, or in hot pitch. All parts of the handrail above ground surface shall be painted with a filler and two coats of white lead paint consisting of 25 pounds of white lead to one gallon of linseed oil with drier as required, and all paint materials are to be of best quality of their various kinds and satisfactory to the Engineers.

103. DITCHING.

For the purposes of drainage for new channels for slough drainage, there may be required certain open ditches. These will be paid for at a price per cubic yard for the volume of the ditch which may be required and specified. Excavation beyond stakes or below grade will not be paid for. The Contractor may, at his convenience, deposit the material taken from such ditches in the embankments and no deduction will be made from the amounts to be paid for embankments on account of such material having been paid for in excavation.

104. RIGHT OF WAY.

The right-of-way controlled by the Purchaser is shown on the drawings. Any additional ground, landing places, pier privileges, or wharfs that the Contractor may require for his operation shall be procured or provided by the Contractor at his own expense.

105. ROYALTIES ON PATENTS.

All fees or royalties for any patented invention, article, or method of construction or maintenance used in this structure or any part thereof, of any materials, tools, implements, machinery, fixtures, or anything used by the Contractor, shall be included in the price stipulated in the contract for the work, and the Contractor shall protect and hold harmless the Purchaser against all demands for such fees, royalties and claims. No charge will be made to the Contractor by the Engineers for the use of their patents in this structure only

106. SCOPE OF CONTRACTS.

The work to be done will be let under the following several contracts to one or more bidders:

Contracts No. 1.

A contract for the manufacture and delivery of superstructure metal work for the bridge over the Columbia River, in case a lift span be installed.

Contract No. 2.

A contract for the erection of the superstructure metal work for the bridge over the Columbia River in case a lift span be installed.

Contract No. 3.

A contract for the manufacture and delivery of the superstructure metal work for the bridge over the Columbia River in case a swing span be installed.

Contract No. 4.

A contract for the erection of the superstructure metal work for the bridge over the Columbia River in case a swing span be installed.

Contract No. 5.

A contract for the manufacture and delivery of the superstructure metal work for the bridge over the Oregon Slough and the bridge over the Columbia Slough.

Contract No. 6.

A contract for the erection of the superstructure metal work for the bridge over the Oregon Slough and the Bridge over the Columbia Slough.

Contract No. 7.

A contract for the substructure in the Columbia River, in case a lift span be installed.

Contract No. 8.

A contract for the substructure in the Columbia River in case a swing span be installed.

Contract No. 9.

A contract for the substructure in the Oregon Slough and in the Columbia Slough.

Contract No. 10.

A contract for the construction of all embankments.

Contract No. 11.

A contract for the construction of reinforced concrete slabs and pavements over all of the steel structure.

Contract No. 12.

A contract for the construction of pavement upon embankment.

107. TIMES OF COMPLETION.

Each contractor shall begin as soon as practicable after the date of signing the contract, and shall carry his work to completion as rapidly as possible.

The Contractor for Contract No. 1 or Contract No. 3, Scope of Contract, shall deliver the spans consecutively proceeding from one side of the river; the first four spans shall be delivered complete in every particular not sooner than August 31, 1915, and not later than October 31, 1915; at least four additional spans shall be delivered by December 31, 1915; and all the remaining spans not later than April 30, 1916.

The Contractor for Contract No. 2 or Contract No. 4, Scope of Contract, shall proceed with erection consecutively from one side of the river; shall complete the erection and riveting of four spans ready for the concrete floor not later than December 31, 1915; and shall complete the erection and riveting of all spans ready for the concrete floor not later than June 30, 1916; and shall entirely complete the contract not later than July 31, 1916.

The Contractor for Contract No. 5, Scope of Contract, shall deliver the spans consecutively beginning at one side of Oregon Slough; shall deliver the first six spans complete in every particular not sooner than August 31, 1915, and not later than October 31, 1915; shall deliver four additional spans by December 31, 1915; and shall deliver the remaining spans not later than March 31, 1916.

The Contractor for Contract No. 6, Scope of Contract, shall proceed with erection consecutively from one side of Oregon Slough; shall complete the erection and riveting of six spans ready for the concrete floor not later than January 31, 1916; and shall complete all spans ready for the concrete floor not later than May 31, 1916, and shall entirely complete the contract not later than June 30, 1916.

The Contractor for Contract No. 7 or Contract No. 8, Scope of Contract, shall complete the piers consecutively from one side of the river; shall have six piers ready for steel not later than October 31, 1915; shall have all the piers ready for steel not later than May 30, 1916; and shall complete the entire contract not later than July 31, 1916.

The Contractor for Contract No. 9, Scope of Contract, shall complete the piers consecutively from one side of Oregon Slough; shall have six piers ready for steel not later than September 30, 1915; shall have all the piers ready for steel not later than April 30, 1916; and shall complete the entire contract not later than June 30, 1916.

The Contractor for Contract No. 10, Scope of Contract, shall complete the construction of all embankments except as may be hindered by the construction of buried piers, by February 28, 1916; shall complete these portions around buried piers as soon as the completion of the concrete work will permit; shall begin the construction of slope protection concrete slabs not earlier than July 31, 1916, and shall complete same and the entire contract by September 30, 1916.

The Contractor for Contract No. 11, Scope of Contract, shall conform to the erection of the spans in the prosecution of the work; shall complete all concrete work not later than July 31, 1916; and shall complete the entire contract not later than September 15, 1916.

The Contractor for Contract No. 12, Scope of Contract, shall begin the construction not sooner than July 31, 1916, and shall complete the same not later than September 15, 1916.

In the event that two or more of the Contracts under Scope of Contract are awarded to one Contractor, the times for completion of such contract items may be relatively altered provided the times of completion are not extended, and provided the times for other Contractors are not changed.

It is the intention to have the entire bridge, and all incidental structures completed and in service not later than October 31, 1916.

108. BIDS.

Bids shall be made by filling out the proposal form in this specification and delivering it in sealed envelope as will be directed.

Every bidder shall submit with his tender a written statement of the plant and machinery proposed for use, and a written program conforming to the clause Plant and Program of Construction, and information as to within what dates the plant and equipment can be in service on the work. There shall also be cited works of similar character and quantity which have been accomplished by the Contractor making the bid, and which may be examined by the Purchaser and the Engineers. These statements will be considered as evidence of the Bidder's experience and of his ability to do the work, and bids not accompanied by such papers shall be considered incomplete, and from inexperienced Contractors, and for such reason will not be considered.

For the manufacture of the metal work, the description of plant and tools shall include only a statement of the shop or shops at which the work is to be fabricated, the capacity or capacities of such shops per month, and the percentage of the time and equipment of such shop or shops which will be devoted to the work.

If the Bidder desires to accept any of the Contracts only on condition of two or more certain Contracts being awarded him, he may so state in his tender; or if he will make a lump sum deduction from the total sums tendered in consideration of two or more Contracts being awarded to him he shall so state in his bid.

Where bids are asked on alternate materials or processes, the Purchaser reserves the right to compare bids upon any alternatives, and to select alternatives at will, and is in no measure bound to accept the lowest alternative.

109. ADHERENCE TO SPECIFICATIONS IN BIDDING.

Bidders are hereby warned that they will be held strictly to the spirit of the specifications, and that it will be bad policy for anyone to bid with the expectation that concessions will be made after the contract is closed, in order that the work may be cheapened or expedited. On this account bidders are respectfully requested not to complicate their tenders by submitting alternative bids based upon proposed changes in either plans or specifications, because such alternative bids will not be considered

110. RATE OF PROGRESS.

The Contractor shall commence work at such points as the Engineer may direct, and shall conform to his directions as to the order and time in which the different parts of the

work shall be done, as well as to the force required to complete the work at the date specified.

If, during construction, it appears to the Engineer that the Contractor is not making proper progress, the Purchaser shall have the right, after giving the Contractor ten days' notice in writing, to undertake himself either by administration or by letting contract to other parties, the completion of the said work which is being thus neglected. Should the Purchaser's work cost less than what the Contractor would have been paid, the difference shall be paid to the Contractor; but, on the other hand, should it cost more, the difference shall be charged to the Contractor, and shall be taken out of the reserved ten per cent or out of the bond.

Under these circumstances the Purchaser shall have the right to enter upon and take temporary possession of the plant, tools, materials and supplies of the said Contractor, or any part thereof. In case that the percentage of earnings withheld by the Purchaser be insufficient to make good the deficit, the Purchaser shall have the right to reimburse himself by the sale of the Contractor's plant; but, otherwise the said plant shall be returned to the Contractor after the completion of the work.

If, in the opinion of the Engineer, the Contractor be delayed or prevented in the prosecution of the work by conditions absolutely beyond the control of the Contractor, additional time for completion of the contract will be allowed, and the amount of such additional time will be determined and fixed solely by the Engineer. It is not anticipated that the Contractor will be able to prosecute the work every day, and weather conditions will not be considered to warrant extensions of time unless unusual and different from average conditions over several years.

If, in the opinion of the Engineers, the shop work is being unnecessarily delayed or is about to be delayed because of non-delivery of any metal or because of the asserted inability of the shop to procure any metal, the purchaser shall have the right, after giving the Contractor five (5) days' notice in writing, to purchase the required metal in open market, to deliver it to the shop, and to charge all costs for material and delivery against the Contractor.

111. LIQUIDATED DAMAGES.

For each day of delay, including Sundays, for each and every of the Contracts No. 1, No. 2, No. 3, No. 4, No. 7 and No. 8, listed under "Scope of Contract," in the completion of such Contracts, or portions of such Contracts, according to the times specified under "Times of Completion," the Purchaser shall withhold permanently for each and every such Contract, from the Contractor's total compensation for that contract, the sum of one hundred dollars. For each day of delay, including Sundays, for each and every of the Contracts No. 5, No. 6, No. 9, No. 10, No. 11 and No. 12, listed under "Scope of Contract, in the completion of such Contracts or portions of such Contracts, according to the times specified under "Times of Completion," the Purchaser shall withhold permanently for each and every such Contract, from the Contractor's total compensation for that contract, the sum of fifty dollars. The amount or amounts thus withheld shall not be considered a penalty, but shall be considered liquidated damages which are fixed and agreed to hereby in advance by the contracting parties.

No allowance shall be made to any Contractor for delay which may be caused him by any other Contractor, except that his time for completion will be extended numerically the number of days, that, in the opinion of the Engineers, he is delayed by any act or omission of other Contractors, and no allowance will be made on account of times or seasons in which his work may be conducted.

If in the opinion of the Engineers and the Board of County Commissioners the Contractor be delayed or prevented in the prosecution of the work by conditions absolutely beyond the control of the Contractor, additional time for the completion of the contract will be allowed, and the amount of such additional time will be determined and fixed by the Engineers and the Board of County Commissioners.

Should any Contractor, for any reason whatsoever, fail to complete the work required under this Contract within the time specified herein for its completion, the Purchaser shall withhold from payment to the Contractor each month and shall pay to the Engineers each month a sum adequate to reimburse the Engineers for all expenses incurred by them in inspecting the materials and supervising the construction of the work after the above specified date for the completion of the work under this Contract. The sum or sums thus

withheld by the Purchaser and paid to the Engineers shall be in addition to the liquidated damages to the Purchaser specified herein.

112. PAYMENTS.

On or about the first day of the month the Engineers will estimate the value of the work done and the materials furnished at site; and within fifteen days thereafter, ninety (90) per cent of the value thus determined, less previous payments shall be paid to the Contractor in cash. Upon the completion of the entire work involved in the contract, and upon the acceptance of the same in writing by the Engineers and by the Purchaser, the balance due the Contractor for the entire work shall be paid to the said Contractor in cash.

The final payment for the Manufacture and Delivery of steel work shall not be made until the entire structure is erected and in operation, and an amount of moneys due, to be fixed by the Engineers, shall be withheld to cover the cost of correction of possible shop errors, and the remainder paid after the complete bridge is accepted.

Before, however, the final payment is made, the Contractor shall show to the Purchaser satisfactory evidence that all just liens, claims, and demands of his employees, or of parties from whom materials used in the construction of the work may have been purchased or procured, are fully satisfied, and that the materials furnished and the work done on the structure are fully released from all such liens, claims, and demands.

If, too, during the progress of the work it appears that the Contractor's bills for materials and labor are not being paid, the Purchaser shall have the right to withhold from the Contractor's monthly payments a sufficient sum or sums to guarantee himself against all losses from mechanics' and other possible liens, and to apply the said sums to the payment of such debts.

The payment of monthly estimates shall not in any respect be taken as an admission by the Purchaser that the work is done or that its quantity or quality is satisfactory, nor as a release of the Contractor from responsibility in respect thereof, but the whole work and all particulars relating thereto shall be subject to revision and adjustment by the Engineers at the time of final acceptance and upon the payment of the final estimate.

The Engineers shall indicate on each estimate the share thereof to be paid by Multnomah County and the share to be paid by Clarke County, and payments will be made accordingly.

113. UNCLASSIFIED WORK.

The Engineers shall have the right to require the Contractors to perform work or supply materials of a class not provided for in the specifications or for which no special price for payment is provided in the contract, to be known as Unclassified Work. In case such work or materials are ordered, they shall be paid for on the basis of actual cost to the Contractor of materials and applied labor plus twenty per cent thereof for his profit, indirect expenses for the use of plant, tools, and appliances. No indirect expense of any kind shall be included in the cost of materials and applied labor. In case completed articles or products ready for installation are furnished instead of the constituent materials, the Contractor will be allowed ten per cent on the cost to him of such articles for profit, indirect expenses, and for use of tools and appliances. No allowance will be made for superintendence, insurance, or any other indirect expense, or for the use of plant, tools and appliances. Satisfactory vouchers will be required from the Contractor for all such expense items.

No bills for unclassified work will be allowed unless the work was ordered before execution in writing by the Engineers, and every claim for unclassified work, for extra work, for additional allowances, not specifically enumerated in the contract, must be presented to the Engineers for allowance by the last day of the month following the month in which it was done or furnished. Otherwise all claims for such items shall be deemed to be absolutely waived by the Contractor, are hereby absolutely waived by the Contractor, and the Purchaser shall not be required to make any payment on such accounts.

114. APPROXIMATE QUANTITIES OF MATERIALS.

The following are the approximate quantities of materials in the structure. They are to be used in comparing tenders, but are in no way considered binding upon the Purchaser or upon the Engineers.

CONTRACTS 1 AND 2.

Superstructure Columbia River Bridge—Lift Span Layout.

1.	Metal in truss spans	12,825,000	Pounds
2.	Metal in girder span	99,000	Pounds
3.	Metal in towers	748,000	Pounds
4.	Structural metal in counterweights	74,000	Pounds
5.	Concrete in counterweights	621	Cu. Yds.
6.	Street car rails and accessories	620,000	Pounds
7.	Sheaves, shafts and bearings on towers	130,000	Pounds
8.	Equalizers and pins	35,000	Pounds
9.	Wire ropes and attachments	95,000	Pounds
10.	Operating machinery, locks, etc.	58,000	Pounds

CONTRACTS 3 AND 4.

Superstructure Columbia River Bridge—Swing Span Layout.

1.	Metal in fixed truss spans	10,482,000	Pounds
2.	Metal in girder span	99,000	Pounds
3.	Metal in swing span above turntable	2,142,000	Pounds
4.	Street car rails and accessories	620,000	Pounds
5.	Metal in drum and structural metal below top of drum	167,000	Pounds
6.	Metal in rollers, racks, tracks and center casting	130,000	Pounds
7.	Machinery	171,000	Pounds
8.	Creosoted piles in draw protection	37,100	Lin. Ft.
9.	Creosoted timber in draw protection	355	M. Ft.BM

CONTRACTS 5 AND 6.

Superstructure—Oregon & Columbia Slough Bridges.

1.	Metal in girder spans, Oregon Slough	2,592,000	Pounds
2.	Metal in girder spans, Columbia Slough	599,000	Pounds
3.	Street car rails and accessories, Oregon Slough	203,000	Pounds
4.	Street car rails and accessories, Columbia Slough	56,000	Pounds

CONTRACT 7.

Substructure—Columbia River Bridge—Lift Span Layout.

1.	Shafts and copings of piers and buried piers	5,350	Cu. Yds.
2.	Reinforcing metal in piers and buried piers	109,000	Pounds
3.	Mass in bases of piers	15,810	Cu. Yds.
4.	Mass in bases of buried piers	418	Cu. Yds.
5.	Piles below bases of piers and buried piers	77,900	Lin. Ft.
6.	Piles in dolphins and for ferry landings	5,900	Lin. Ft.
7.	Timber in ferry landings	105	M.Ft.BM
8.	Rip-rap around piers	16,000	Cu. Yds.
9.	Willow mattresses	34,600	Sq. Yds.

CONTRACT 8.

Substructure—Columbia River Bridge—Swing Span Layout.

1.	Shafts and copings of piers and buried piers	6,790	Cu. Yds.
2.	Reinforcing metal in piers and buried piers	114,000	Pounds
3.	Mass in bases of piers	18,100	Cu. Yds
4.	Mass in bases of buried piers	418	Cu. Yds.
5.	Piles below bases of piers and buried piers	85,800	Lin. Ft.
6.	Piles in dolphins and for ferry landings	5,900	Lin. Ft.
7.	Timber in ferry landings	105	M.Ft.BM
8.	Rip-rap around piers	17,000	Cu. Yds.
9.	Willow mattresses	38,300	Sq. Yds.

CONTRACT 9.

Substructure—Oregon & Columbia Slough Bridges.

1.	Shafts and copings of piers and buried piers	2,480	Cu. Yds.
2.	Reinforcing metal in piers and buried piers	34,000	Pounds
3.	Mass in bases of piers	2,310	Cu. Yds.
4.	Mass in bases of buried piers	894	Cu. Yds.
5.	Piles below bases of piers and buried piers	58,100	Lin. Ft.
6.	Rip-rap around piers	11,000	Cu. Yds.
7.	Willow mattresses	21,000	Sq. Yds.

CONTRACT 10.

Embankments.

1.	Embankment north of Columbia River	22,000	Cu. Yds.
2.	Embankment on Hayden Island	95,000	Cu. Yds.
3.	Embankment south of Oregon Slough	814,000	Cu. Yds.
4.	Ditch excavation	3,000	Cu. Yds.
5.	Slope protection concrete slabs	38,000	Sq. Yds.
6.	Clearing on Hayden Island	4	Acres
7.	Rock fill at buried piers	1,900	Cu. Yds.

CONTRACT 11.

Floor Slabs and Pavements on Steel Structures.

1.	Gross area of floor between outside faces of curbs	21,624	Sq. Yds.
2.	Net area of sidewalk slabs	3,254	Sq. Yds.
3.	Concrete in posts and handrails at Vancouver end of Columbia River Bridge	21	Cu. Yds.
4.	Concrete in roadway slabs and curbs	2,768	Cu. Yds.
5.	Concrete in rail headings	749	Cu. Yds.
6.	Bar reinforcement in roadway slabs and curbs	323,000	Pounds
7.	Wire reinforcement in roadway slabs and curbs	270,000	Pounds
8.	Concrete in sidewalk slabs	350	Cu. Yds.
9.	Wire reinforcement in sidewalk slabs	21,000	Pounds

CONTRACTS 12.

Pavements on Embankments.

1.	Pavement on embankments south of Columbia River	26,600	Sq. Yds.
2.	Timber handrails on embankments south of Columbia River	168	M.Ft.BM
3.	Pavement in Vancouver	2,540	Sq. Yds.
4.	Curbs in Vancouver	37	Cu. Yds.
5.	Sidewalks in Vancouver	1,030	Sq. Yds.

115. AWARD OF CONTRACT.

As soon as possible after the award of contract is made, the contract as outlined on the accompanying form shall be signed in triplicate by the successful bidder, after which copies will be signed by the Purchaser and one copy will be retained by each of the parties to the agreement, and one copy by the Engineers.

116. ASSIGNING OR SUBLETTING CONTRACT.

The Contractor shall not assign or transfer this contract nor sublet any part thereof without the written consent of both the Engineers and the surety on the Contractor's bond; the written consent of his surety to such transfer or subletting shall also be filed with the Engineers; no subcontract or transfers of contract shall in any circumstances relieve the Contractor of his liabilities under this contract. Should any subcontractor fail to perform the work undertaken by him in a satisfactory manner, the Engineers may at their option annul and terminate such subcontract.

Copies of all subcontracts as are permitted are to be delivered to the Engineers.

117. BONDS.

Each Contractor entering into contract for any portion of the work will be required to give to the Purchaser a Bond, satisfactory to the Purchaser, for the faithful performance of the covenants, conditions and agreements undertaken to be performed under the contract, plans, and specifications, and of all terms and conditions therein contained, within the prescribed time, and also for any period of extension that may be granted on the part of the Purchaser, and as well for all changes, alterations, or modifications of the contract as are permitted by the specifications and the contract; for the prompt payment of all laborers, mechanics, sub-contractors and material men, and all persons who shall supply all such laborers, mechanics or sub-contractors with materials, supplies, or provisions for carrying on such work, and all just dues and demands incurred in the performance of the work; for the payment to the Purchaser of such liquidated damages as may accrue to the Purchaser under the contract; and to indemnify and save harmless the Purchaser against any direct and indirect damages that may be suffered or claimed, or from injuries to or loss of materials paid for by the Purchaser either partially or in full, or injuries to persons or property during the construction of said work, and until the same is accepted, and against claims for royalties on patents.

118. MEANING OF TERMS.

Wherever in these specifications the term "Purchaser" is employed, it is understood to refer to the Interstate Bridge Commission, consisting of the Commissioners of Multnomah County, Oregon, representing Multnomah County, and the Commissioners of Clarke County, Washington, representing Clarke County.

Wherever in these specifications the term "Engineer" or "Engineers" is employed, it is understood to refer to Waddell & Harrington, E. E. Howard and L. R. Ash, Associate Engineers, Consulting Engineers; or their duly authorized representatives. Wherever the term "Inspector" or "Inspectors" is used, it is understood to refer to representatives of the Engineers.

Wherever the term "Contractor" is employed, it is understood to mean any person or corporation that may have entered into a contract with the Purchaser for his work or any portion thereof. Every reference to "Contractor" applies equally to all Contractors connected with the work unless there is specific limitation to the contrary.

THE

PACIFIC HIGHWAY

INTERSTATE BRIDGE OVER THE COLUMBIA RIVER and APPROACHES

FROM

VANCOUVER, WASHINGTON, to PORTLAND, OREGON

FOR

MULTNOMAH COUNTY, OREGON, CLARKE COUNTY, WASHINGTON

PROPOSAL AND BID

To

The Columbia River Interstate Bridge Commission,

The Commissioners of Multnomah County, Oregon,

The Commissioners of Clarke County, Washington,

Acting for

Multnomah County, Oregon, and Clark County, Washington,

The undersigned bidder declares that he has read the specifications and contract, that he has examined and understands the plans, that he has examined the site and has determined for himself the conditions affecting the work so far as the items herein bid upon are concerned; and he proposes, and agrees, if this proposal is accepted, to provide at his own expense all labor, machinery, plant, tools, apparatus, appliances, and means of construction, and all materials not specifically excepted, and to construct complete the items bid upon, in the manner and times prescribed, including all work incidental to or described or implied as incidental to such items, according to the plans, specifications, and the instructions of the Engineers, and that he will accept in full payment therefor, sums according to the following schedule of rates and prices.

BID FOR CONTRACT NO. 1, SCOPE OF CONTRACT.

For the manufacture and delivery of superstructure metal work for the bridge over the Columbia River, in case a lift span is installed:

Shall include the furnishing, manufacture, transportation and delivery f. o. b, cars or c. i. f. boats or barges at Vancouver, Washington, of all the superstructure metal work; street railway rails, bonds, and fastenings; machinery; mechanical parts; operating devices; gas engines and accessories; electric motors; controllers; indicators; and all electrical equipment except the electric wiring and conduits, and except the signal and service lights, lanterns, and attachments.

	Approximate Quantity	Approximate Total
1. For all metal work in truss spans and in end girder span, including shoes, castings, drain castings and downspouts, expansion plates, handrails, anchor bolts, and every other metal part except as hereinafter specified,		
.....		
cents ( ) per pound of metal	**12,924,000 Pounds**	
2. For all metal work in towers, including front columns from the top of the floor beam and rear columns and bracing from the top chords of the span and for all structural metal in counterweights,		
.....		
cents ( ) per pound of metal	**822,000 Pounds**	
3. For street car rails, splice bars, bolts, clips, bolts for fastening to structural steel, manganese gap bars, derailing switches, operating pipes and supports, and parts of operating mechanism for derailing switches up to gates, for all track bonding material except solder, and for all other track appurtenances,		
.....		
cents ( ) per pound of metal	**620,000 Pounds**	
4. For all sheaves, shafts, bearings, gears, pinions, couplings, levers, equalizer bars and pins, movable trolley devices for street car trolleys, and for mechanisms attached to movable trolleys, for all parts of hand brakes and attachments, for cast machinery and drum bases, for drums, for rollers and bearings for operating cables, for corner deflecting sheaves, for span locks, for all machinery up to and including the coupling on the end of the motor counter shaft and up to and including the coupling on the slow speed shaft of the gear reducer, and for all wire ropes and attachments,		
.....		
cents ( ) per pound of metal	**318,000 Pounds**	

	Approximate Quantity	Approximate Total
5. For two operating motors equipped with solenoid brakes, with back gears and counter shafts, and for controllers and resistances,		

.....

dollars ($).

6. For switchboard, switches, circuit breakers, meters, cut-outs, limit switch cut-outs, and all switchboard appurtenances, except wiring,

.....

dollars ($).

7. For the gasoline engine with distributor, coil box, battery, tanks, piping, and other engine accessories, for the clutch and clutch parts down to pin connecting to the clutch operating rod, for the contained gear reducer, and every part up to the coupling on the slow speed shaft of the gear reducer,

.....

dollars ($).

BID FOR CONTRACT NO. 2, SCOPE OF CONTRACT.

For the erection of the superstructure metal work for the bridge over the Columbia River, in case a lift span is installed:

Shall include receiving, checking, unloading promptly, storing and caring for all metal work, machinery, and equipment for the superstructure specified under Contract No. 1; being responsible for all the demurrage due to cars or vessels not being promptly unloaded, transporting from point of delivery to site, erecting, riveting, adjusting, cleaning, furnishing the paint and painting all such materials; furnishing and applying oil for machinery and grease for guides; furnishing and applying dressing for cables; furnishing all materials, and building complete operators' and gate tenders' houses, platforms, runways and the concrete slabs supporting the gate tenders' houses; furnishing all materials except structural steel and building complete the concrete counterweights; erecting engines, motors, controllers and electrical equipment; furnishing and placing all electric wiring and conduits from the source of supply, including the trolley bars on the towers and the collectors on the movable span; furnishing and erecting all signal and service lights and lanterns, the wiring, connections and switches therefor; erecting and adjusting all street car rails and attachments, and placing all track materials and bonding, furnishing solder therefor; furnishing and placing all other materials except the concrete floor, sidewalk and paving, and finishing the entire superstructure complete; performing all work necessary to put the bridge in perfect operating condition, and furnishing the necessary labor and materials except gasoline, oil, and electric current, and operating the bridge for sixty days after its completion, delivering it at the end of that period properly adjusted and in perfect working condition:

1. For all metal work in truss spans, and in end girder span, including shoes, castings, expansion plates, drain castings and down-spouts, handrails, anchor bolts, and every other metal part except as hereinafter specified,		

.....

cents ( ) per pound of metal.....12,924,000 Pounds

	Approximate Quantity	Approximate Total
2. For all metal work in towers, including front columns from the top of the floor beam, and rear columns and bracing from the top chords of the span, and for all structural metal in counterweights,		
.....		
cents ( ) per pound of metal.....	**822,000 Pounds**	
3. For street car rails, splice bars, bolts, clips, bolts for fastening to structural steel, manganese gap bars, derailing switches, operating pipes and supports, and parts of operating mechanisms for derailing switches up to gates, for all track bonding, and for all other track appurtenances,		
.....		
cents ( ) per pound of metal.....	**620,000 Pounds**	
4. For all sheaves, shafts, bearings, gears, pinions, couplings, levers, equalizer bars and pins, movable trolley devices for street car trolleys, and for mechanisms attached to movable trolleys, for all parts of hand brakes and attachments, for cast machinery and drum bases, for drums, for rollers and bearings for operating cables, for corner deflecting sheaves, for span locks, for all machinery up to and including the coupling on the end of the motor counter shaft and up to and including the coupling on the slow speed shaft of the gear reducer, and for all wire ropes and attachments,		
.....		
cents ( ) per pound of metal.....	**318,000 Pounds**	
5. For two operating motors equipped with solenoid brakes, with back gears and counter shafts, for controllers and resistances, for switchboard, switches, circuit breakers, meters, cut-outs, limit switch cut-outs, and all switchboard appurtenances, except wiring,		
.....		
dollars ($).		
6. For the gasoline engine with distributor, coil box, battery, tanks, piping, and other engine accessories, for the clutch and clutch parts down to pin connecting to the clutch operating rod, for the contained gear reducer, and every part up to the coupling on the slow speed shaft of the gear reducer,		
.....		
dollars ($).		

	Approximate Quantity	Approximate Total
7. For all electric wiring and conduits from the source of supply, including trolley bars on the towers and collectors on the movable span, and for all signal and service lights and lanterns, the wiring, conduits, cut-outs, fuses, connections and switches therefor, and for the signal bell,		
..... dollars ($).		
8. For the construction complete of the operator's house, including every item of material above the top of the steel floor on which the house stands, and including the specified equipment in the house,		
..... dollars ($).		
9. For the construction complete of two gate tenders' houses including every item of material, including the concrete slabs on which the houses stand, and including the specified equipment in the house,		
..... dollars ($).		
10. For furnishing all materials, except enclosed structural steel, and building, erecting, adjusting, and painting, and completing the counterweights,		
..... dollars ($) per cubic yard of concrete	621 Cu. Yds.	

BID FOR CONTRACT NO. 3, SCOPE OF CONTRACT.

For the manufacture and delivery of the superstructure metal work for the bridge over the Columbia River, in case a swing span is installed:

Shall include the furnishing, manufacture, transportation, and delivery f. o. b. cars, or c. i. f. boats or barges at Vancouver, Washington, of all the superstructure metal work, street railway rails, bonds and fastenings, machinery, mechanical parts, operating devices, gas engines and accessories, electric motors, controllers, indicators and all the electrical equipment except the electric wiring and conduits and except the signal and service lights, lanterns and attachments.

1. For all metal work in the fixed truss spans, and in the end girder span, including shoes, castings, drain castings and downspouts, expansion plates, handrails, anchor bolts, and every other metal part except as hereinafter specified,		
..... cents ( ) per pound of metal.....	10,581,000 Pounds	

	Approximate Quantity	Approximate Total
2. For all metal work in swing span, including shoes, castings, drain castings and down-spouts, expansion plates, handrails, anchor bolts, and every other metal part except as hereinafter specified,		
.....		
cents ( ) per pound of metal.....	2,142,000 Pounds	
3. For all metal work on pivot pier below the top flange of the drum except the operating pinions, the shafts connected thereto, and the cast steel bearings for these shafts.		
.....		
cents ( ) per pound of metal.....	297,000 Pounds	
4. For street car rails, splice bars, bolts, clips, bolts for fastening to structural steel, manganese gap bars, derailing switches, operating pipes and supports, and parts of operating mechanism for derailing switches up to gates, for all track bonding material except solder, and for all other track appurtenances except as specified with machinery,		
.....		
cents ( ) per pound of metal.....	620,000 Pounds	
5. For all gears, pinions, shafts, couplings, bearings, levers, for cast machinery bases, for all hand brakes and attachments, for end lifting toggles, bearings, and all moving parts connected to toggles, for attachments connecting the movable gap bars to other machinery parts and for all machinery up to and including the coupling on the end of the motor counter shaft and up to and including the coupling on the slow speed shaft of the gear reducer,		
.....		
cents ( ) per pound of metal.....	171,000 Pounds	
6. For the two motors turning the swing span and the motor operating the end lifting toggles, each equipped with solenoid brake, with back gear and counter shaft, and for all controllers and resistances,		
.....		
dollars ($).		

	Approximate Quantity	Approximate Total
7. For switchboard, switches, circuit-breakers, meters, cut-outs, limit switch cut-outs, and all switchboard appurtenances except wiring,		

.....

dollars ($).

8. For the gasoline engine turning the swing span and the gasoline engine operating the end lifting toggle, each with distributor, coil box, battery, tanks, piping, and other engine accessories, for the clutches and clutch parts down to the pin connecting to the clutch operating rod, for the contained gear reducers, and every part up to the coupling on the slow speed shaft of the gear reducer,

.....

dollars ($).

BID FOR CONTRACT NO. 4, SCOPE OF CONTRACT.

For the erection of the superstructure metal work for the bridge over the Columbia River in case a swing span is installed:

Shall include receiving, checking, unloading promptly, storing and caring for all metal work, machinery and equipment for the superstructure, specified under Contract No. 3; being responsible for all demurrage due to cars or vessels not being promptly unloaded, transporting from point of delivery to site, erecting, riveting, adjusting, cleaning, furnishing the paint and painting all such materials; furnishing and applying oil and grease for machinery; furnishing all materials and building complete operators' and gate tenders' houses and the concrete slabs supporting the houses; furnishing all materials and building complete the creosoted timber and pile draw protection; erecting engines, motors, controllers and electrical equipment; furnishing and placing all electric wiring and conduits from the source of supply; furnishing and placing the subaqueous cables; furnishing and erecting all signal and service lights and lanterns, the wiring connections and switches therefor; erecting and adjusting all street car rails and attachments, and placing all track materials and bonding, furnishing solder therefor; furnishing and placing all other materials except the concrete floor, sidewalk and paving, and finishing the entire superstructure complete; performing all work necessary to put the bridge in perfect operating condition; and furnishing the necessary labor and materials, except gasoline, oil and electric current, and operating the bridge for sixty days after its completion, delivering it at the end of that period properly adjusted and in perfect working condition:

1. For all metal work in the fixed truss spans, and in the end girder span, including shoes, castings, drain castings and down-spouts, expansion plates, handrails, anchor bolts, and every other metal part except as hereinafter specified,

.....

cents ( ) per pound of metal.....10,581,000 Pounds

2. For all metal work in swing span, including shoes, castings, drain castings and down-spouts, expansion plates, handrails,

	Approximate Quantity	Approximate Total
anchor bolts, and every other metal part except as hereinafter specified,		
.....		
cents ( ) per pound of metal.....	2,142,000 Pounds	
3. For all metal work on pivot pier below the top flange of the drum except the operating pinions, the shafts connected thereto, and the cast steel bearings for these shafts,		
.....		
cents ( ) per pound of metal.....	297,000 Pounds	
4. For street car rails, splice bars, bolts, clips, bolts for fastening to structural steel, manganese gap bars, derailing switches, operating pipes and supports, and parts of operating mechanisms for derailing switches up to gates, for all track bonding, and for all other track appurtenances, except as specified with machinery,		
.....		
cents ( ) per pound of metal.....	620,000 Pounds	
5. For all gears, pinions, shafts, couplings, bearings, levers, for cast machinery bases, for all hand brakes and attachments, for end lifting toggles, bearings, and all moving parts connected to toggles, for attachments connecting the movable gap bars to other machinery parts and for all machinery up to and including the coupling on the end of the motor counter shaft and up to and including the coupling on the slow speed shaft of the gear reducer,		
.....		
cents ( ) per pound of metal.....	171,000 Pounds	
6. For the two motors turning the swing span and the motor operating the end lifting toggles, each equipped with solenoid brake, with back gear and counter shaft, and for all controllers and resistances; for switchboard, switches, circuit-breakers, meters, cut-outs, limit switch cut-outs, and all switchboard appurtenances except wiring,		
.....		
dollars ($).		
7. For the gasoline engine turning the swing span and the gasoline engine operating the end lifting toggles, each with dis-		

	Approximate Quantity	Approximate Total
tributor, coil box, battery, tanks, piping, and other engine accessories, for the clutches and clutch parts down to the pin connecting to the clutch operating rod, for the contained gear reducers, and every part up to the coupling on the slow speed shaft of the gear reducer,		
.....		
dollars ( ).		
8. For all electric wiring and conduits from the source of supply, including subaqueous cables, and all appurtenances for electric wiring, and for all signal and service lights and lanterns, the wiring, conduits, cut-outs, fuses, connections and switches, therefor, and for the signal bell,		
.....		
dollars ($).		
9. For the construction complete of the operator's house, including every item of material including the concrete slab on which the house stands, and including the specified equipment in the house,		
.....		
dollars ($).		
10. For the construction complete of two gate tenders' houses, including every item of material including the concrete slabs on which the houses stand, and including the specified equipment in the houses,		
....		
dollars ($).		
11. For creosoted piles in place in the draw protection,		
.....		
cents ( ) per lineal		
foot of the piles below the cut-off.....	37,100 Lin. Ft.	
12. For creosoted timber and lumber in the draw protection, including all bolts, spikes, and other fastenings, including the wire rope, metal plates, and attachments,		
.....		
dollars ($) per		
M. Ft. B. M. of timber in place.....	355 M. Ft. B. M.	

BID FOR CONTRACT NO. 5, SCOPE OF CONTRACT.

For the manufacture and delivery of the superstructure metal work for the bridge over the Oregon Slough and the bridge over the Columbia Slough:

Shall include the furnshing, manufacture, transportation and delivery f. o. b. cars or c. i. f. boats or barges at Vancouver, Washington, of all of the superstructure metal work, street railway rails, bonds and fastenings.

	Approximate Quantity	Approximate Totai
1. For all metal work in girder spans, including shoes, castings, drain castings and down-spouts, expansion plates, handrails, anchor bolts, and every other metal part except as hereinafter specified,		
.....		
cents ( ) per pound of metal.....	**3,191,000 Pounds**	
2. For street car rails, splice bars, bolts, clips, bolts for fastening to structural steel, manganese gap bars, for all track bonding material except solder, and for all other track appurtenances,		
.....		
cents ( ) per pound of metal.....	**259,000 Pounds**	

BID FOR CONTRACT NO. 6, SCOPE OF CONTRACT.

For the erection of the superstructure metal work for the bridge over the Oregon Slough and the bridge over the Columbia Slough:

Shall include receiving, checking, unloading promptly, storing and caring for all metal work of the superstructures specified under Contract No. 5; being responsible for all demurrage for cars or vessels not being promptly unloaded, transporting from point of delivery to site, erecting, riveting, adjusting, cleaning, furnishing the paint and painting all such materials; erecting and adjusting all street car rails and attachments and placing all track materials and bonding, furnishing solder therefor:

1. For all metal work in girder spans, including shoes, castings, drain castings and down-spouts, expansion plates, handrails, anchor bolts, and every other metal part except as hereinafter specified,		
.....		
cents ( ) per pound of metal.....	**3,191,000 Pounds**	
2. For street car rails, splice bars, bolts, clips, bolts for fastening to structural steel, manganese gap bars, for all track bonding, and for all other track appurtenances,		
.....		
cents ( ) per pound of metal.....	**259,000 Pounds**	

BID FOR CONTRACT NO. 7, SCOPE OF CONTRACT.

For the substructure in the Columbia River in case a lift span is installed:

Shall include furnishing all materials for and constructing complete all piers, buried piers, pier rip-rap or mattress work, temporary ferry landing and ferry runways in the Columbia River from Vancouver to Hayden Island.

	Approximate Quantity	Approximate Total
1. For concrete in shafts and copings of all piers and buried piers, above the tops of bases,		
.....		
dollars ( ) per cubic yard.....	5,350 Cu. Yds.	
2. For all reinforcing metal in piers and buried piers,		
.....		
cents ( ) per pound of metal.....	109,000 Pounds	
3. For the mass in bases of piers from the bottom of base to the top of base,		
dollars ($) per		
cubic yards of mass.....	15,810 Cu. Yds.	
4. For the mass in bases of buried piers, from bottom of base to top of base,		
dollars ($) per		
cubic yard of mass.....	418 Cu. Yds.	
5. For all piles below the bottoms of bases of piers and buried piers,		
cents ( ) per lineal		
foot of pile below the bottoms of bases.....	77,900 Lin. Ft.	
6. For piles in dolphins for ferry landing for the Portland Railway Light and Power Company's ferry, and for piles under runways for said ferry,		
cents ( ) per lineal		
foot of pile below cut-off.....	5,900 Lin. Ft.	
7. For all timber and lumber in temporary ferry landings or in temporary runways for same, for above ferry, including bolts, spikes, or other fastenings,		
.....		
dollars ($) per M. Ft. B. M.....	105 M. Ft. B. M.	

	Approximate Quantity	Approximate Total
8. For natural or artificial rip-rap stone, deposited around piers, dollars ($) per cubic yard of stone in place	16,000 Cu. Yds.	
9. For willow mattresses, woven and sunk into place, including the preparation of the riverbed therefor, all materials in the mattress, and the weighting stone placed on top, cents ( ) per square yard of mattresses in place	34,600 Sq. Yds.	

BID FOR CONTRACT NO. 8, SCOPE OF CONTRACT.

For the substructure in the Columbia River in case a swing span is installed:

Shall include furnishing all materials for and constructing complete all piers, buried piers, pier rip-rap or mattress work, temporary ferry landing, and ferry runways in the Columbia River from Vancouver to Hayden Island.

1. For concrete in shafts and copings of all piers and buried piers, above the tops of bases, ... cents ( ) per cubic yard	6,790 Cu. Yds.	
2. For all reinforcing metal in piers and buried piers, ... cents ( ) per pound of metal	114,000 Pounds	
3. For the mass in bases of piers from the bottom of base to the top of base, dollars ( ) per cubic yard of mass	18,100 Cu. Yds.	
4. For the mass in bases of buried piers, from bottom of base to top of base, dollars ($) per cubic yard of mass	418 Cu. Yds.	
5. For all piles below the bottom of bases of piers and buried piers, cents ( ) per lineal foot of pile below the bottoms of bases	85,800 Lin. Ft.	
6. For piles in dolphins for ferry landing for the Portland Railway, Light and		

	Approximate Quantity	Approximate Total
Power Company's ferry, and for piles under runways for said ferry, cents ( ) per lineal feet of pile below cut-off	5,900 Lin. Ft.	
7. For all timber and lumber in temporary ferry landings or in temporary runways for same for above ferry, including bolts, spikes, or other fastenings. ..... dollars ($) per M. Ft. B. M.	105 M. Ft. B. M.	
8. For natural or artificial rip-rap stone, deposited around piers, dollars ($) per cubic yard of stone in place	17,000 Cu. Yds.	
9. For willow mattresses, woven and sunk into place, including the preparation of the riverbed therefor, all materials in the mattress, and the weighting stone placed on top, cents ( ) per square yard of mattress in place	38,300 Sq. Yds.	

BID FOR CONTRACT NO. 9, SCOPE OF CONTRACT.

For the substructure in the Oregon Slough and in the Columbia Slough:

Shall include furnishing all materials for and constructing complete all piers, buried piers, pier rip-rap or mattress work, in the Oregon Slough and in the Columbia Slough:

1. For concrete in shafts and copings of all piers and buried piers, above the tops of bases, ... cents ( ) per cubic yard	2,480 Cu. Yds.	
2. For all reinforcing metal in piers and buried piers, ... cents ( ) per pound of metal	34,000 Pounds	
3. For the mass in bases of piers from the bottom of base to the top of base, dollars ($) per cubic yard of mass	2,310 Cu. Yds.	

	Approximate Quantity	Approximate Total
4. For the mass in bases of buried piers, from bottom of base to top of base, dollars ($) per cubic yard of mass	894 Cu. Yds.	
5. For all piles below the bottoms of bases of piers and buried piers, cents ( ) per lineal foot of pile below the bottoms of bases	58,100 Lin. Ft.	
6. For natural or artificial rip-rap stone, deposited around piers, dollars ($) per cubic yard of stone in place	11,000 Cu. Yds.	
7. For willow mattresses, woven and sunk into place, including the preparation of the riverbed therefor, all materials in the mattress, and the weighting stone placed on top, cents ( ) per square yard of mattress in place	21,000 Sq. Yds.	

BID FOR CONTRACT NO. 10, SCOPE OF CONTRACT.

For the construction of all embankments:

Shall include furnishing all materials for and constructing complete all embankments, including any additional material for shrinkage and subsidence, rock fills at buried piers, ditches for drainage, and concrete slabs on the slopes of embankments.

1. For all embankments in place complete, cents ( ) per cubic yard of the volume contained between the present ground surface, the required final elevation, and the required net side slopes of embankment	931,000 Cu. Yds.	
2. For the excavation of drainage ditches where required, cents ( ) per cubic yard of the net volume of the excavation specified	3,000 Cu. Yds.	
3. For the construction of the slope protection concrete slabs, and including all work incidental thereto. cents ( ) per square yard of concrete slab	38,000 Sq. Yds.	

	Approximate Quantity	Approximate Total
4. For rock fills at the foot of embankments at certain buried piers, dollars ($) per cubic yard of rock in place.....	1,900 Cu. Yds.	

TENDER FOR CONTRACT NO. 11, SCOPE OF CONTRACT.

For the construction of reinforced concrete slabs and pavements over all the steel structures:

Shall include furnishing all materials of every kind, including reinforcement for and constructing complete all of the concrete roadway slabs, curbs, gutters, sidewalk slabs, rail headings, and the hard surface pavement on the roadway, over all portions of the steel structures, including the Bridge over the Columbia River, the Bridge over the Oregon Slough and the Bridge over the Columbia Slough; furnishing all materials for and constructing complete the concrete hand rails and the ornamental concrete posts.

1. For all materials except the street car rails and connections, in place between the planes of the outside faces of the curbs with sheet asphalt pavement, dollars ($) per square yard for the gross area measured between the planes of the outside faces of the curbs	21,624 Sq. Yds.	
2. For all materials except the street car rails and connections in place between the planes of the outside faces of the curbs with asphaltic concrete pavement. dollars ($) per square yard for the gross area measured between the planes of the outside faces of the curbs	21,624 Sq. Yds.	
3. For all materials except the street car rails and connections in place between the planes of the outside faces of the curbs with Bitulithic pavements, dollars ($) per square yard for the gross area measured between the planes of the outside faces of the curbs.....	21,624 Sq. Yds.	
4. For sidewalk slabs, cents ( ) per square yard of the net area of the slab surface in place beyond the plane of the outer face of the curb	3,254 Sq. Yds.	
5. For the construction of the concrete handrails and the ornamental concrete posts at the Vancouver end of the Columbia River Bridge, including all the reinforcement		

	Approximate Quantity	Approximate Total
therein and all of the surface finishing required,		
dollars ($) per		
cubic yard of concrete in place.....	21 Cu. Yds.	
6. For the bronze lamp standards, lamps and globes, on top of ornamental concrete posts, including fastenings,		
dollars ($) for		
equipment complete for one post.		

TENDER FOR CONTRACT 12, SCOPE OF CONTRACT.

For the construction of pavements upon embankments:

Shall include furnishing all the materials for and constructing complete all of the hard surface pavements upon embankments, and the hand rails upon embankment, including preparing the embankments therefor.

1. For pavement in place complete, if of concrete pavement. No. One.		
dollars ($) per		
square yard of surface.....	26,600 Sq. Yds.	
2. For pavement in place complete, if concrete pavement No. Two (of Hassam),		
dollars ($) per		
square yard of surface.....	26,600 Sq. Yds.	
3. For pavement in place complete, if composed of concrete slab, with sheet asphalt wearing surface,		
dollars ($) per		
square yard of surface.....	26,600 Sq. Yds.	
4. For pavement in place complete, if composed of concrete slab with asphaltic concrete wearing surface,		
dollars ($) per		
square yard of surface.....	26,600 Sq. Yds.	
5. For pavement in place complete, if composed of concrete slab with Bitulithic wearing surface,		
dollars ($) per		
square yard of surface.....	26,600 Sq. Yds.	

	Approximate Quantity	Approximate Total
6. For pavement in place complete, if composed of broken stone base with asphaltic concrete No. One wearing surface, dollars ($) per square yard of surface.....	26,600 Sq. Yds.	
7. For pavement in place complete, if composed of broken stone base with asphaltic concrete No. Two (Bitulithic) wearing surface, dollars ($) per square yard of surface.....	26,600 Sq. Yds.	
8. For handrails constructed in place complete, including all fastenings, dollars ($) per M. Ft. B. M. of timber.....	168 M. Ft. B. M.	
9. For curbs built in Washington Street and First Street, Vancouver, dollars ($) per cubic yard of concrete.....	37 Cu. Yds.	
10. For sidewalks on embankments in Washington Street and First Street in Vancouver, cents ( ) per square yard of sidewalk surface.....	1,030 Sq. Yds.	

The preceding tenders are made subject to my receiving the following Contracts:

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In the event of the following several contracts being awarded to me, the following lump sum deductions will bo made:

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A check certified by ..... in the amount

of .....

accompanies this tender.

A letter, offering to provide the bond, by the..... ....

.....

accompanies this tender.

If this proposal shall be accepted and the undersigned shall fail to enter in contract as aforesaid, and to give the required bond in satisfactory form within fifteen days from the dete of mailing a notice to him according to the address herein given that the contract is ready for signature, the Purchaser may, at his option, declare that the bidder has abandoned the contract, and thereupon this proposal and the acceptance thereof shall be

null and void, and the forfeiture of the certified check accompanying this proposal shall operate and the same shall be property of the Purchaser.

Signature of Bidder:

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.....

.....

Business Address:

.....

.....

.....

Local Address:

.....

.....

.....

Date: .....

CONTRACT

BETWEEN

Contractor:

AND

Purchaser:

FOR

Dated.....

MEMORANDUM OF AGREEMENT, Made and signed this.....day of

....., by and between.....

the party of the first part, and sometimes termed in this agreement and in the specifications the "Purchaser," and

the party of the second part, and sometimes termed in this agreement and in the specifications the "Contractor."

WHEREAS,

WHEREAS, The Contractor has, under date of....., made a satisfactory tender for

NOW THIS AGREEMENT WITNESSETH:

First. The Contractor, for and in consideration of certain payments to be made to him as hereinafter specified, hereby covenants and agrees to provide, at his own cost and expense, all labor, machinery, plant, tools, and appliances, and to

all in accordance with the Plans and Specifications hereunto annexed and made a part hereof, and will fully finish and complete the same by

but, if, in the opinion of the Engineer, the Contractor be delayed or prevented in the prosecution of the work by conditions absolutely beyond the control of the Contractor, additional time for completion of the contract will be allowed, and the amount of such additional time will be determined and fixed solely by the Engineer.

Second. The Contractor shall start the work of construction as soon as practicable after the signing of the contract, and shall carry on the work with adequate diligence to ensure its completion within the time specified.

Third. In consideration of the performance by the **Contractor** of his covenants and agreements, as herein set forth, the **Purchaser** hereby covenants and agrees to pay the **Contractor** the schedule of rates and prices set forth in the attached **PROPOSAL AND BID.**

In case the **Engineer** requires the **Contractor** to perform work or to supply materials of a class not included and covered in the above list of items nor, in the opinion of the **Engineer,** described or implied as included in the above list by the plans and specifications, such materials and work shall be paid for as provided in the clause for **Unclassified Work** in the attached specifications.

No payments, either partial or final, are to be made for any material which is to be used for falsework or plant; but payment is to be made only for materials which are left permanently in the finished structure and form a part of it. The **Engineer** may, at his discretion, allow temporary partial payments in advance of the permanent work as materials for plant and falsework are employed, but the **Contractor** shall have no right to demand such compensation.

Fourth. The schedule prices to be employed in making partial payments for all work as it progresses are to be as follows:

The **Engineers** shall fix the schedule prices in the monthly estimates for all materials not covered in the preceding list.

Fifth. All materials paid for by the Purchaser shall be deemed to have been delivered to, and to have become the property of the said Purchaser, but the Contractor hereby agrees to store it and to become responsible for it during the continuance of this agreement. If any of it be lost, damaged, or destroyed by floods, washouts, or fires, or by any other means whatsoever, the Contractor shall repair or replace the same at his own expense and to the satisfaction of the Engineer.

Sixth. If the Contractor fails to complete the work within the time specified, and if the Purchaser shall nevertheless permit the said Contractor to proceed, and continue, and complete the same, as if such time had not lapsed, such permission shall not modify nor waive in any respect any forfeiture or liability of the Contractor for damages arising from such non-completion of said work within the time specified, and covered by the "Liquidated Damages" clause of the specifications; but such liability shall continue in full force against the said Contractor, as if such permission had not been granted.

Further, if the Contractor fails to complete the work within the time specified, no partial estimates will be rendered and no payments will be made after the date specified for completion until the Contractor shall deliver to the Engineer for each and every such partial payment the written consent of the Contractor's Surety, permitting such payment to be made without affecting the validity of the Bond.

Seventh. No change or alteration shall be made in the terms or conditions of this agreement without the consent of both parties hereto in writing; and no claim shall be made or considered for any additional or unclassified work unless the same shall be authorized and directed in writing by the Engineer.

Eighth. The Contractor hereby assumes the risk of the occurrence of delays in the prosecution and completion of the work embraced in this contract; and the amounts hereinbefore mentioned to be received by the Contractor in payment for the work include and cover that risk, and therefore the Contractor shall be entitled to no additional compensation on account of any such delays.

Ninth. The Contractor hereby agrees that he will at all times keep within his control the work covered in this contract and will not assign or sub-let all or any portion of it without the written consent of the Purchaser.

Tenth. The decision of the Engineer shall at all times control as to the interpretation of drawings and specifications for the work; but if either the Purchaser or the Contractor shall consider himself aggrieved by any such decision of the Engineer he may require the dispute to be finally and conclusively settled by the decision of arbitrators, one to be appointed by the Purchaser, and a second by the Contractor. In case the two arbitrators thus chosen fail to agree, a third arbitrator shall be appointed by

By the decision of these arbitrators, or by that of a majority of them, both parties to this agreement shall be finally bound.

Eleventh. The Contractor is to indemnify the Purchaser against all liability or damages on account of accidents occasioned, or claimed to be occasioned, by the omission or negligence of himself, his agents, or his workmen during the continuance of this agreement, and against all claim for royalties on patents; therefore it is hereby agreed that the Contractor shall be promptly and duly notified in writing by the Purchaser of the bringing of any suit or suits on such accounts against the Purchaser, and shall be given the option of assuming the sole defense thereof. It is also agreed that the Contractor is to pay all judgments obtained by reason of accidents or patents in any suit or suits against the Purchaser, including all legal costs, court expenses, and other like expenses.

Twelfth. The Contractor further agrees to furnish and maintain in force during the continuance of this contract, a penal bond satisfactory to the Purchaser in the sum of

.....

.....

dollars for the faithful performance of the said contract and all provisions thereof.

Thirteenth. The Contractor further agrees to promptly, as due, make payments to all persons supplying to such Contractor labor or material for the prosecution of the work provided for herein, and that said Contractor shall not permit any lien or claim to be filed or prosecuted against the Purchaser, for account of any labor or material furnished, and that no person shall be employed by said Contractor for more than eight (8) hours in any one day, or forty-eight (48) hours in any one week, unless in case of emergency when no other competent labor is available, and in such cases such laborer shall be paid double wages for all overtime.

Fourteenth. The Contractor further agrees that this agreement may be cancelled at the election of the Purchaser for any wilful failure or refusal on the part of the Contractor to faithfully perform the Contract according to its terms and conditions.

Fifteenth. The Contractor further agrees that Clarke County, Washington, shall retain six and one-half per cent of the Contractor's payroll for all labor performed in the State of Washington until the Contractor shall present a receipt in full for all premiums demanded of it by the State Industrial Commission of the State of Washington, in compliance with the Workmen's Compensation Act; that before final payment on this Contract is made, a Bill of Clearance from the said State Industrial Commission must be presented to Clarke County, Washington, showing that all and every demands by said Commission have been paid.

Sixteenth. The Contractor further agrees that any person who has supplied labor or material for the prosecution of any work provided for under this contract is hereby authorized to institute an action against said Contractor or his sureties on his own relation in the name of the Purchaser, and to prosecute the same to final judgment for his own use and benefit.

Seventeenth. The Contractor further agrees that all the provisions of the laws of the State of Washington and State of Oregon, applicable to the protection of sub-contractors, material-men and laborers engaged in carrying out the terms of this contract, are hereby made a part of this contract whether expressly incorporated herein or not.

Eighteenth. Nothing in this contract or the proposal or accompanying papers shall be construed to authorize or recognize in any way any sub-contract.

Nineteenth. The word "Engineer" or "Engineers" as used in this Contract and in the Specifications shall mean Waddell & Harrington, E. E. Howard and L. R. Ash, Associate Engineers, Consulting Engineers, or their duly authorized representative.

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IN WITNESS WHEREOF, The parties to this agreement have hereunto set their hands and seals.....

.....

.....

.....

Dated the day and year first herein written.

Purchaser:

MULTNOMAH COUNTY, OREGON,

By.....
Governor of the State of Oregon

By.....County Commissioner

By.....County Commissioner

By.....County Commissioner

Attest:

.....
County Clerk

CLARKE COUNTY, WASHINGTON,

By.....County Commissioner

By.....County Commissioner

By.....County Commissioner

Attest:

.....
County Auditor

Party of the First Part

Contractor:

.....

.....

.....

.....

.....

.....

Party of the Second Part

Approved as to form.

.....

District Attorney for Multnomah County, Oregon.

Approved as to form.

.....

Prosecuting Attorney for Clarke County, Washington.

BOND

To Accompany Contract Between

Contractor:

AND

Purchaser:

FOR

BY

Surety:

KNOW ALL MEN BY THESE PRESENTS:

That we, (1).....

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as principal, and (2).....

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as suret....., are jointly and severally held and bound unto.....

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hereinafter called the Purchaser, in the penal sum of.....

.....

dollars ($.....), lawful money of the United States of America, ([2])

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for the payment of which sum, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

The obligor.... herein expressly agree.... that ([4a]) a *joint action may be brought against all of them—the judgment against each surety therein to be limited to the amount for which.....is bound;* or a joint action may be brought against the said Principal and *each* ([4b]) surety for the amount in which such surety is bound jointly and severally with said principal; or a several action may be brought against *each* ([4c]) obligor for the amount for which such obligor is liable.

The Condition of This Obligation Is Such, That, whereas on the.....

.....day of..... A. D.....

the said (5).....

.....

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.....

Principal herein, made and entered into a certain contract, copy of which is hereto annexed, with the Purchaser for (6).....

.....

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.....

according to the plans, specifications, and schedule of rates and prices made a part of said contract.

Now, Therefore, if the said Principal herein, ... heirs, executors, administrators, or successors shall and will, in all respects, faithfully and truly observe and comply with the terms, conditions, and provisions of the said contract, and shall well and truly and fully do and perform all and singular the covenants, conditions, agreements, matters and things by the said (7).....

.....

.....

agreed, covenanted, and undertaken to be performed under said contract, plans, and specifications, upon the terms proposed therein, and within the time prescribed therein, and as well during any period of extension of said contract as may be granted on the part of the Purchaser, and as well for all changes, alterations or modifications of the said contract as are permitted by the specifications and contract; and shall promptly pay all laborers, mechanics, sub-contractors, and material men, and all persons who shall supply such laborers, mechanics or sub-contractors with materials, supplies or provisions for carrying on such work, all just debts, dues, and demands incurred in the performance of such work; and shall pay the Purchaser such liquidated damages as may accrue to the Purchaser under said contract; and shall indemnify and save harmless the Purchaser against any direct and indirect damages that shall be suffered or claimed, and from injuries to or loss of materials paid for by the Purchaser either partially or in full, or injuries to persons or property during the construction of said

work and until the same is accepted; and against claims for royalties on patents; and shall in all respects faithfully perform said contract according to law, then this obligation shall be void and of no effect; otherwise, to remain in full force and virtue.

It is understood that the enumeration of particular obligations under this bond shall not be construed as a waiver by the Purchaser of any of the terms, covenants and conditions of said contract.

IT IS HEREBY STIPULATED, that action on this bond may be brought by said Purchaser as plaintiff, or in the name of said Purchaser as plaintiff for the use of any person, firm or corporation entitled to institute such action by virtue of any law in the

.....Court of.....

.....

and if at the time of the action (8) any of the obligor..... is not found within the

jurisdiction of said Court, service of process as to such obligor..... may be made by delivering a copy of the same to the Clerk of said Court, who is hereby appointed agent

of the obligor..... for that purpose; that no person shall be disqualified to act as a juror therein by reason of his being a resident and property owner of the County or State in which such action is commenced.

IN WITNESS WHEREOF, The parties hereunto have executed this instrument under

their several seals this.....day of.....A. D. 1915, (the

(9) name and corporate seal of said principal being hereto affixed and these presents

duly signed by.....

.....

its (10).....pursuant to a resolution of its (11)

.....

passed on the.....day of....., 1915,) and the name and corporate seal of said surety being hereto affixed and these presents duly signed by

....., its (12).....pursuant

to a resolution of its (13).....passed

on the.....day of....., 1915.

.....(Seal)

.....(Seal)

.....(Seal)

PRINCIPAL

In the presence of

.....

.....

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SURETY

Attest:

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SURETY

Attest:

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.....

INFORMATION.

With reference to execution of bonds.

1. If the principal is a corporation, insert the name and add the words "a corporation existing under the laws of the State of" (*giving the state*). If the principal is an individual, insert his name, place of business, and state. In case of a firm, the names of the individual partners will be given, followed by the recital that they are partners composing a firm named (*giving the name of the firm, the place of business, and state*); and the bond must be executed by all the partners.

2. If the surety is a corporation, insert the name and add the words "a corporation existing under the laws of the State of" (*giving the state*). If more than one surety join in the bond, repeat the words quoted after each corporate name. If the surety is an individual, insert his name, place of business, and state.

3. In the event that more than one surety joins in the bond here insert "with each surety as hereinafter specified, and the said (*naming surety*), jointly and severally with said

principal...., in the sum of.....dollars of said penal sum and no

more; and the said.....(*naming additional surety*),

jointly and severally with said principal.... in the sum of.....

.....dollars, of said penal sum and no more."

4. In the event that one surety only gives the bond, eliminate the underscored words marked (4a), (4b) and (4c), and substitute for the word in (4c) the word "the."

5. Here insert the name of the principal, the manner of transacting business and the place of business as heretofore outlined under paragraph one.

6. Here insert descriptive matter covering the scope of the contract. In the event that one bidder secures a contract for the entire work or several contracts for various portions of the work (*as outlined by the specifications*), the purchaser reserves the right to require separate bonds to secure each separate contract, rather than to accept one bond to secure all contracts.

7. Here insert name of principal as heretofore outlined under paragraphs one and five.

8. If one surety gives the bond strike out the underscored words at number (9).

9. If the principal is not a corporation, strike out the words in parenthesis marked (10). Bond must be executed by all partners.

10. President or other officers authorized to sign for the principal. A copy of the record of the selection of the officer or officers executing the bond for the principal, certified by the custodian of such records, under the corporate seal, to be a true copy, must accompany or be attached to the bond, unless the resolution authorizing its execution gives the names of the officer or officers, in which case no other evidence of their official character is required.

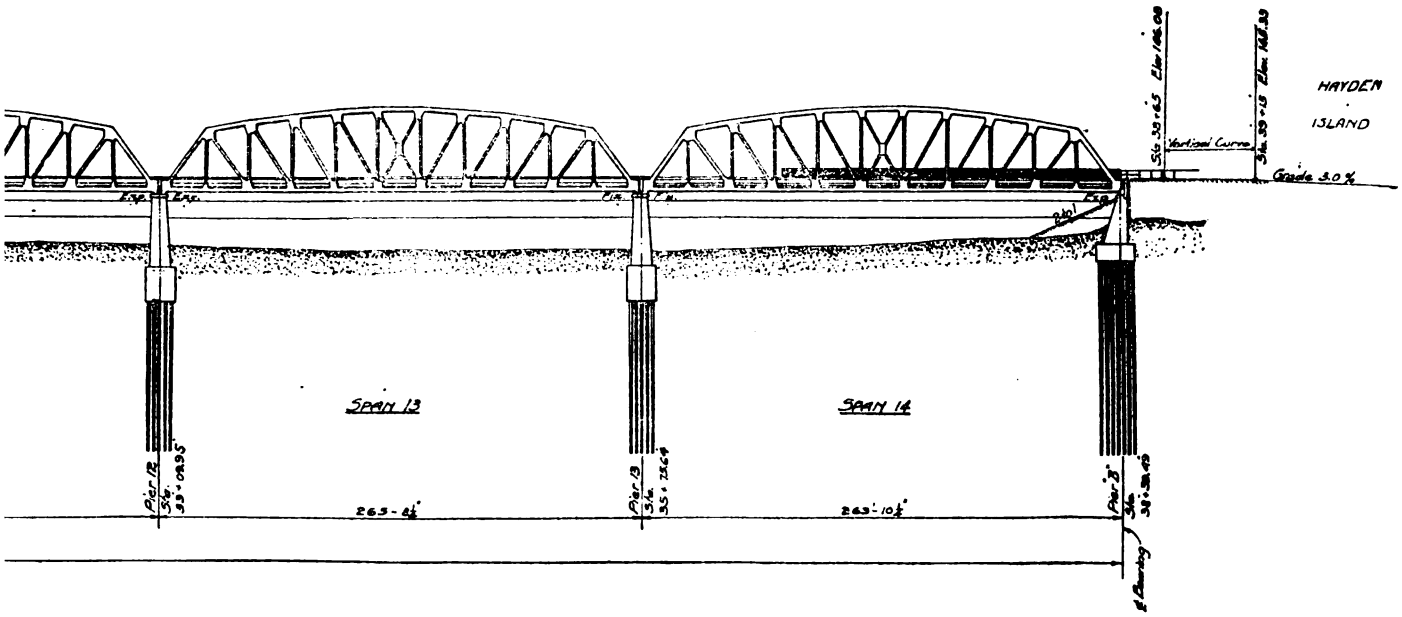
11. Board of Directors or other governing body of the principal. A copy of the by-law or of the record of proceedings of the governing body of the corporation showing the authority of the officer or officers executing the bond for the principal, must accompany or be attached to the bond, the same to be certified by the custodian of such records, under the corporate seal, to be a true copy. If the authority was given by resolution, enough of the records must be copied, along with the resolution, to show that it was adopted, and the entire matter copied (*not simply the resolution*) will be certified to be a true copy. If the authority is a by-law, the wording of the executing clause will be altered accordingly.

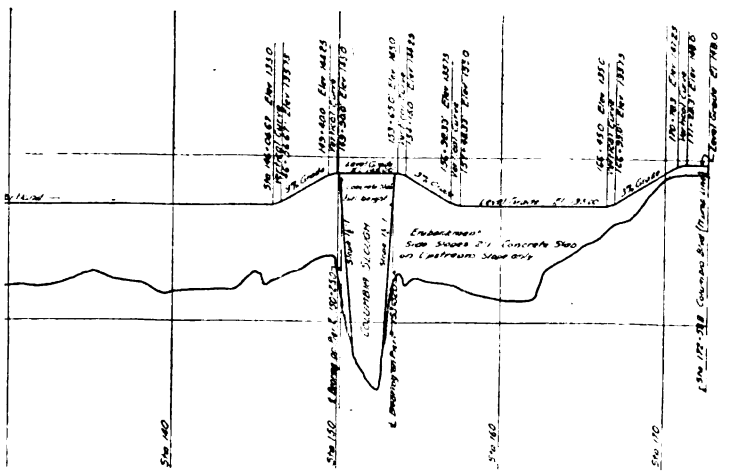
12. President or other officers authorized to sign for the surety. The same proof of the selection thereof to be furnished as by the principal under paragraph ten hereof.

13. Board of Directors or other governing body of the surety. The same proof of authority to be furnished as by the principal under paragraph eleven hereof.

14. The individual members of a firm will execute the bond as individuals. One member signing for another must have proper Power of Attorney. If the principal or surety be a corporation, the name and corporate seal will be affixed by the proper officer, followed by the name and official designation of such officer.

INDEX TO SPECIFICATIONS





PACIFIC HIGHWAY

INTERSTATE BRIDGE

OVER THE

COLUMBIA RIVER

VANCOUVER, WASH. TO PORTLAND ORE.

MULTNOMAH COUNTY AND CLARKE COUNTY

LIFT SPAN LAYOUT
GENERAL PLAN

Scale: as noted

Made by F.M.C. Date 12-12-14

Traced by M.G.G. Date 12-19-14

Checked by R.F.Y. Date 2-23-15

WADDELL & HARRINGTON
F.E.Howard and L.R.Ash
Associate Engineers
CONSULTING ENGINEERS

SHEET NO. 5