

A DESCRIPTION OF UNDER-PINNING PROCEDURE AND OF THE EQUIPMENT AND MATERIAL USED

Thesis for the Degree of C. E. MICHIGAN STATE COLLEGE Edward M. Young 1940

A DESCRIPTION OF UNDER-PINNING PROCEDURE AND OF THE EQUIPMENT AND MATERIAL USED

by

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B.S. in C.E.1915

A THESIS

Submitted to the Graduate School of Michigan State College of Agriculture and Applied Science impartial fulfilment of the requirements for the degree of

CIVIL ENGINEER

Department of Engineering

Year 1940

FIGHT

THESIS

The author wishes to acknowledge his indebtedness to Mr. Archibald Dudgeon, president of the Richard Dudgeon Company who gave liberally of his time and also furnished illustrative material for the hydraulic jack, the principle machine used in under-pinning.

To the other firms also contributing illustrative material bound in this thesis, general acknowledgement is here made. Specific references to these firms are to be found in the body of this work.

To Michigan State College, where from 1911 to 1915 the author spent four very happy years; to Edward his older son, now a senior there, and to Robert, the younger, who will soon matriculate there, and who at the writing of this thesis lies dangerously hurt in a New York hospital as a result of an accident on a construction job, this thesis is affectionately dedicated.

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Plate #1 follows page #4 - Queens under-pinning job

Plate #2 follows page #7 - Dudgeon plain jacks

Plate #3 follows page #8 - Jack and pump used

Plate #4 follows page #8 after plate #3 - Triplex pump

Plate #5 follows page #8 after plate #4 - Pump details

Plate #6 follows page #9 - Acetylene torch

Plate #7 follows page #9 after plate #6 - Diaphragm pump

Plate #8 follows page #9 after plate #7 - Centrifugal pump

Plate #9 follows page #11 - Demolition tool or air hammer

Plate #10 follows page #12 - Detail of 16" point and sleeve

Plate #11 follows page #10 - Building and footing details

Plate #12 follows page #20 - Assembly of under-pinning unit

Plate #13 follows page #24 - 300 ton jack

Plate #14 follows page #25 - Double acting jack

Plate #15 follows page #25 after plate #14 - Rack and pinion
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retracting jack

with the expansion of the transportation systems by means of underground tunnels for street railways, underriver tunnels, for both vehicular traffic and railways and with the construction of water mains, sewers, aqueducts, and the like, the need of a better method of under-pinning became apparent. Under the existing method, the necessity of extending footings for heavy buildings below the sub-grade of the subway tunnels involved slow tedious work and expensive construction. Under-pinning was necessary to relieve the excessive pressure on the tunnel walls, and to maintain the resisting value of the soil under adjacent footings which cause lateral pressures. 1.

Error in judgment as to bearing value of soil is often the reason for high cost of building maintenance. Many

of footings and to a depth below the bottoms of the footings, it is necessary to sheet the walls of the cut to prevent lateral movement of the earth. Even though it may be very carefully done, the installation of the sheeting disturbs the soil and thus much of the bearing value of the earth under the footing is lost. It is therefore always good practice to extend the under-pinning below the lowest point of cut. When the entire proceedure is through rock or other materials of adequate bearing capacities which are not subject to lateral movements when under pressure, no under-pinning is necessary.

times a contractor is called upon to install a foundation for a new project, part of which lies on bed rock, and the remainder on piles. In this case, to compensate for any variation in sustaining power, the foundation is generally designed to sustain loads from 50% to 100% in excess of maximum conditions. In other cases there may be changing water levels, due, for example, to construction of subway tunnels or tunnels for large sewers, which would result in lowering the old water level formerly considered permanent.

In the case of steel piles, cut off may be made at any elevation, but it should be understood that the protective oxide must not be removed. When iron rusts, the exide formed on the outside completely protects the pile. If removed, new oxide forms reducing the net section of steel, until finally after repeated removal of this oxide we find a pit or a hole completely through the steel casing. If this casing is surrounded by earth the shell will last indefinitely. Consequently the bearing power of the pile will be sustained as long as this oxide is never removed.

In the case of wood piles, however, changing water level may be a very serious matter. A wood pile will last indefinitely if completely submerged. Where complete immersion has been the history, piles have been inspected and found to be in perfect condition after hundreds of

years in service.

A short time ago, an investigation was made on the American Aluminium Company dock at Edgewater, New Jersey, and it was found that below the low water level the piles were in perfect condition while above tide water they were almost completely gone because of dry-rot. In a case of this sort it is necessary either to drive new piles or, starting from a point below that which has been affected, to splice the old ones.

The author was asked recently to supply an underpinning schedule for a Honeywell Avenue, New York City
building which was supported on wood piles. A test pit
below the footings under the walls revealed a serious case
of dry-rot, which as previously explained, might be attributed to the lowering of the water level by the construction
of subway tunnels in the vicinity.

Although it was known this building had been settling it was thought that no serious change was imminent, until the front wall buckled and showered the entrance of this large apartment building with bricks. The test pits mentioned above indicated that virtually half the building foundation was inadequate due to dry-rot of the wood piles, and it was necessary, therefore, to under-pin it by the same system which will be described later in this thesis.

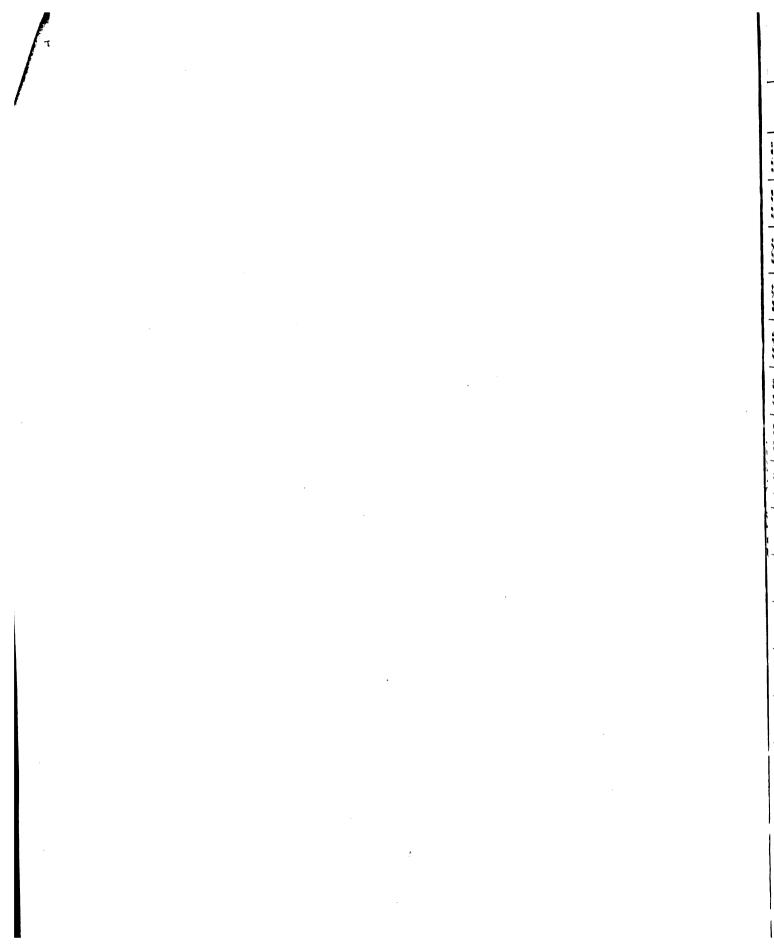
Occasionally it is discovered that piles are over loaded.

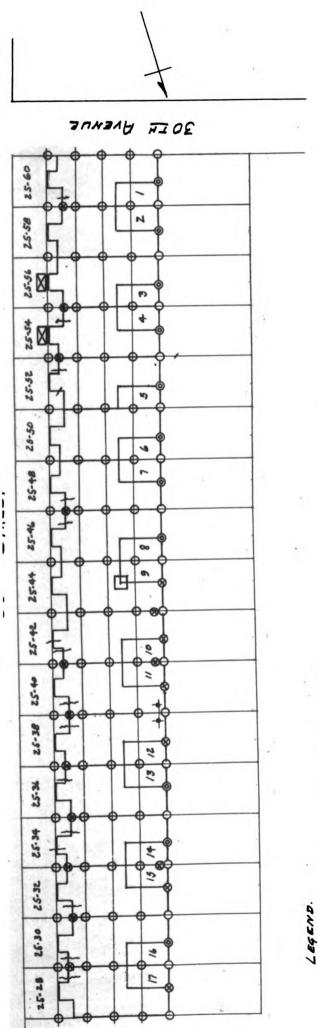
One such condition was found in a former swampy section in

the Borough of Queens, New York City. Here the foundations of seventeen one-femily, attached buildings failed and caused considerable damage to the walls and ceilings of the structures. The author of this thesis was engaged as a consultant to investigate, report, and recommend method of procedure to arrest the settlement of the structures. In this case also, the same procedure discussed in this paper was suggested and carried out with entirely satisfactory results. The investigation in this case proved piles over loaded almost 100%. In addition to this, it was believed the piles had not been driven to the proper resistance. Plate Number 1 shows the detail of procedure and indicates position of new piles placed to arrest the settlement causing the damage.

In 1930 the Rivoli Theatre in Rutherford, New Jersey with proscenium wall of 75' in height, was condemned when large cracks appeared in this and several other sections of the building. Here "open-end" under-pinning piles 16" in diameter were used, and the procedure which will be outlined in this thesis was followed, except that no point was used on the piles and the cleaning of piles was accomplished by means of small orange peel buckets. The author of this thesis installed the system with entirely satisfactory results. In the case of the Rivoli Theatre, investigation of the foundation conditions showed inadequate footings under the points of largest concentrations.

In the old system of under-pinning, the method generally





Suggesting Proceedure Must BE THIS PLAY TOGETHER WITH LETTER CAKEFULLY FOLLOWED IN EYERY PETRIL

PILES PRACES IN PLACE AT A PLINT OF FAILURE O PILES DRIVEN IN ACCORDANCE WITH ORIGINAL DESIGN

® PLES TO BE JAINED AT POINT OF FALLING ® PLES SUGGESTED AS PRECAUTOWARY MEASURE STEPS TO BE PROPERED AND PLEBULT

SPECIAL FOOTING WEDGE + DAY PACK SETTLEMENT CANCKS IN MASOKKY.

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Co. 1NC YOUNG CONTABLTING CO. IN. 74 YARICK ST. NEW YORK CITY HNDERPINNING SCHEDULS FOR BLTE ST & 30 TO AVENUE FEBRUARY 20, 1939. DEPENDABLE HOMES Seare 1: 20'

AFFER FINAL TEST UNTIL STAUT TO BE NEOSED THE STAUT, Louenere BEAM 0-1-4 6" H 5-0" Low DUNHA 12. Pre 1.045 6 5 Bean Strut

TYPICAL TROCEEDUNG

SCALE

used consisted in excavating under 4' to 8' sections of the foundation walls or footings and downward to the point where lateral pressures exerted by the footings of the structure no longer would effect the tunnels which were to be installed. These new footings thus installed were generally of concrete or masonry resting on satisfactory bearing soil and built up to the under side of the existing footings to a point where it was possible to begin wedging and drypacking. This method however did not prevent the possibility of further settlement when the full load of the building was transferred to the new section or sections. principally due to the fact that it was impossible. because of lack of facilities, to depress each new foundation section to a point where it would reach equilibrium before the actual transfer of the load. Generally in this case, therefore, settlement was experienced after the installation of the under-pinning and sometimes necessitated extensive repairs to the super-structures.

The conditions described above led to the development in 1901 of a patented steel pile which consisted of a steel pipe installed in short sections by means of hydraulic jacks, and, when completed, filled with concrete.

It is the author's intent to discuss in detail in this thesis the application of the method developed to meet the need explained in the preceding paragraphs; to discuss the machinery used, the method of procedure, and to suggest

improvements for construction of the hydraulic jack. The suggested improvement of the jack will speed up the method of under-pinning considerably, especially in a case of long sections of foundation where a jacking beam might be placed underneath.

While this thesis treats primarily of the method of utilizing hydraulic jacks, complete presentation of the subject necessitates occasional reference to, or comparison with, other systems of under-pinning.

The first consideration in the modern under-pinning process is the personnel. Three men are generally used in each unit, a dockbuilder foreman, one dock-builder and one laborer. Other men however are required for the excavating of the approach pits by which the three men may enter the point beneath the footing where the under-pinning is to start. The foreman dock-builder directs all work, and because of the limited space in which it is necessary to function, he is generally a working foreman, who, with the aid of the laborer and the other dock-builder, handles all equipment and materials. The second dock-builder is really the assistant to the foreman, and the laborer carries out the orders. No particular qualifications are required of these men except that all of them be in such physical condition as to permit them to do heavy work under the most trying conditions.

The next consideration is the equipment used. The first

in order would be the hydraulic jack, which, because of the fact that it is handled in a limited working space, must be as light in weight as possible, yet consistent with good design, for the tonnage which these jacks exert is tremendous. Hydraulic jacks are of many types and vary in size and shape. The jacks used by the author's concern on the job to be described were manufactured by the Richard Dudgeon Company of New York City, manufacturers of jacks for ninety years. 1.

The jacks used were $2l\frac{1}{2}$ " in height when collapsed, $33\frac{1}{2}$ " when open, and had a capacity of 60 tons. The diameter of the ram was 5" and the cylinder 7 5/8". When depressed, the jack appears to be a simple cylinder without base or head. When elevated, it looks much like one cylinder sliding within another. The weight of the cylinder and ram is

1. The Dudgeon jacks were selected because of their convenience in handling, their light weight and their having a long "run-out" or maximum opening for length of jack. Although the principles of hydraulics were known in 1664, it was not until 1795 that the hydraulic press was invented by Joseph Bramah, in England, and it was not until 1849 that the hydraulic jack was invented by Richard Dudgeon, in America. It is interesting to note that while 54 years elapsed between the invention of the press and the jack, the hydraulic jack was one of the earliest adaptations to practical use of the principle of the hydraulic press. The jack designed at that time and as shown on Plate Number 2 is used largely today.

BOUBLE PUMP 30 TONS AND OVER.



\$150 185 225 285 TRAVERSE JACK 250 275 310 425 30 in. ii: : :







Price same as on 3d page

OUTSIDE PUMP

Original Inventor, Patentee and Manufacturer of the Hydraulic Jack

CONTROLLER OF PATENTS

For the same, dated:

UDGEON'S

February 2, 1882 January 23, 1883

May 6, 1884

August 1, 1865 April 15, 1873

July 8, 1851

體 None are Genuine Without Trade Mark

September 13, 1887 November 17, 1885 September 13, 1887 November 17, 1885 January 12, 1886

Established 1850

RICHARD DUDGEON, 24-26 COLUMBIA ST., NEW YORK

Original Inventor, Patentee and Manufacturer of

Hydraulic Jacks * Hydraulic Punches and Roller Tube Expanders

Also Manufacturer of ALL KINDS OF HYDRAULIC PRESSES, FOR WHEELS, CRANK PINS, MANDRELS, BROACHING, STRAIGHTENING and GENERAL USE



Further information on application to R. DUDGEON, 24-26 Columbia Street, New York

267 lbs. Plate Number 3 shows this little machine which has a 60 ton lift.

The pump for operating the jack is also of many types. The pump and jack may be had as a single unit, but the one chosen for this job was the separate unit and was the hand operated type. This pump weighs 187 lbs., and its assembly is shown on Plate Number 3. The details of this pump are clearly indicated on Plate Number 5.

Accumulators which are a series of power driven pumps have been used in the past for large projects, but they are seldom used today because single motor driven units are available which are much less expensive and more flexible to operate. A later development of this type is known as the Triplex Pump shown on Plate Number 4.

The fluid transmission lines which connect the pump with the jack are usually of copper, tested for high pressures. Gauges used for reading actual pressures or loads depend on plunger areas and are calibrated for direct reading. Siamese connections are used when it is desirable to operate two jacks with one pump. This connection is a T shaped affair, the leg of the T being connected to the pump and either end of the cross of the T being connected to a jack.

In the under-pinning process it is also necessary to use acetylene torches. The acetylene torch is an instrument whereby predetermined mixture of oxygen and acetylene

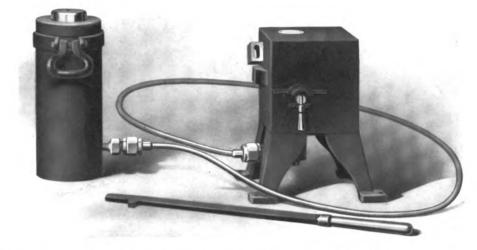
Richard Dudgeon's Universal Hydraulic Double Pump Jack with Standard Length Independent Cylinder and Ram

HIS type is intended to meet the demand for a simple, efficient and reliable jack with an independent pump, connected with the cylinder by means of a flexible copper pipe. The pipe is 12 feet long, unless otherwise ordered, and is included in the price of the jack. The cylinders and rams are of the standard length and are capable of lifting a live load the full runout of the jack.

The pump contains a double pump, so that when the load is light, the double pump will raise it with twice the speed of the single pump. When the load is heavy, a quarter turn of the valve handle will throw out one pump, and give the action of a single pump jack.

It can be lowered by either the lever or the valve handle, and as the valves can be operated independently of the pumping mechanism, they may be opened and cleared of any obstruction preventing their proper seating by working the pump.





The pump is operated in the usual way, excepting in respect to the valve handle. When both pumps are used, turn the valve handle to the left; when one pump only is required, turn it straight downward. To lower the jack, turn the valve handle to the right, or use the lever in the ordinary manner. To reach the valves, unscrew the bonnet, when the valves and the removable seat will drop out. To reach the piston packings, unscrew the plate in the top of the cistern and lift the piston through the opening.

-					, -	WW.J	STILL STATE	hat for	120	F# 3"	miena.	71	·		-		
No.	Lift Tons	Run Out Inches	Diameter of Ram Inches	Diameter of Cylinder Inches	Height of Jack with Ram Down Inches	Weight of Cylinder and Ram Pounds	Price	Code	No.	Lift Tons	Run Out Inches	Diameter of Ram Inches	Diameter of Cylinder Inches	Height of Jack with Ram Down Inches	Weight of Cylinder and Ram Pounds	Price	Code
		_		1		-	-		_		-	-			-	_	
950	40	4	4	61/8	111/2	90	\$280	Hawthorn	984	150	8	8	121/8	171/2	544	\$440	Jovial
951	40	6	4	618	14	112	285	Hazel	985	150	12	8	121/8	22/2	708	450	Jubilee
952	40	8	4	61/8	16	129	290	Hearty	986	170	4	81/2	1278	13	444	440	Justice
953	40	12	4	61/8	21	165	300	Heather	987	170	6	81/2	1278	151/2	556	445	Juvenile
954	50	4	41/2	678	111/2	113	300	Helmet	988	170	8	812	127/8	171/2	614	450	Justify
955	50	6	41/2	638	14	1 140	305	Helpful	989	170	12	81/2	12 7/8	221/2	799	460	Kaiser
956	50	8	1 41/2	678	16	161	310	Hemlock	990	190	4	9	1358	131/2	518	450	Kavlin
957	50	12	41/2	67/8	21	213	320	Herald	100	190	6	9	135/8	16	616	460	Kevstone
958	60	4	5	7.58	12	144	320	Hermit	992	190	8	9	135/8	18	707	475	Kindred
959	60	6	5	758	141/2	179	325	Hickory	993	190	12	9	135/8	23	916	500	King
gho	60	8	5	758	161/2	206	330	Highland	994	235	4	10	151/8	14	664	480	Knight
951	60	12	5	75/8	211/2	267	340	Highway	995	235	6	10	151/8	161/2	Soi	495	Keenness
962	70	4	51/2	833	12	184	340	Homestead	ggb	235	8	10	151/8	1812	897	510	Kirmess
963	70	6	51/2	838	1412	230	345	Impact	997	235	12	10	151/8	231/2	1154	550	Kindness
964	70	8	51/2	83%	161/2	264	350	Imperial	998	285	4		165/8	141/2	811	510	Kinglike
965	70	12	51/2	1 83/8	211/2	342	360	Implicit	999	285	1 6	11	165%	17	949	530	Kirk
966	85	4	6	91/8	12	205	360	Index	1000	285	8	11	165/8	19	1077	550	Knighthood
967	85	6	6	91/8	141/2	256	365	Indigo	1001	285	12	11	165/8	24	1372	600	Knowledge
968	85	8	6	91/8	161/2	293	370	Industry	1002	340	4	12	181/8	15	1030	540	Kohinoor
969	85	12	6	01/8	211/2	382	380	Infantry	1003	340	6	12	181/8	171/2	1204	570	Labyrinth
470	100	4	61/2	978	121/2	252	380	Inland	1004	340	8	12	181/8	191/2	1367	600	Lacquer
971	100	6	61/2	97/8	15	310	385	Inlet	1005	340	12	12	181/8	241/2	1734	650	Lacrosse
972	100	8	61/2	978	17	355	390	Insignia	1006	400	4	13	1958	15	1212	590	Ladder
973	100	12	61/2	978	22	457	400	Institute	1007	400	6	13	1958	1712	1415	620	Landau
974	115	- 4	7	1058	121/2	299	400	Intrinsic	1008	400	8	13	1958	191/2	1604	650	Landscape
975	115	- 6	7	105/8	15	356	405	Iris	1000	400	12	13	195/8	241/2	2036	700	Lantern
976	115	8	7	1058	17	412	410	Island	1010		4	14	211/8	151/2	1453	640	Larch
977	115	12	7	1058	22	538	420	Isthmus	1011	460	6	14	2118	18	1600	670	Larkspur
978	130	4	71/2	113/8	121/2	334	420	Ivory	1012	400	8	14	211/8	20	1948	700	Lattice
979	130	6	71/2	113/8	15	400	425	Jasmine	1013	460	12	14	2118	25	2409	750	Launch
980	130	8	71/2	113/8	17	466	430	Jasper	1014	530	4	15	23	16	1723	680	Laureate
981	130	12	71/2	113/8	22	611	440	Jingle	1015		6	15	23	181/2	1995	715	Laurel
982	150	4	8	121/8	13	394	430	Jonquil	1016		8	15	23	201/2	2248	750	Lavender
983	150	6	8	121/8	151/2	481	435	Journey	1017	530	12	15	23	251/2	2823	800	League
7-3	.30	U		/0	.3/2	1	433	3	/	330		. 3	-3	-3/2	3		Longue

Gauges showing pressure per square inch in pounds, and total pressure on the ram in tons, and provided with a safety check valve, will be furnished, attached, for \$30.00, net, extra.

Cable Address: "Dudgeon"
Lieber's Standard, AI, ABC 5th Edition
Western Union and Private
Codes Used

Richard Dudgeon, Inc.

Columbia and Broome Streets, New York

atented

Oct. 16, 1906 Sept. 22, 1908 Oct. 15, 1907 Nov. 24, 1908 Dec. 24, 1907 Jan. 12, 1909 Aug. 11, 1908 Mar. 2, 1909

Other Patents Pending

Richard Dudgeon's Universal Hydrostatic Triplex Single Pump Motor Driven Pressure Pump



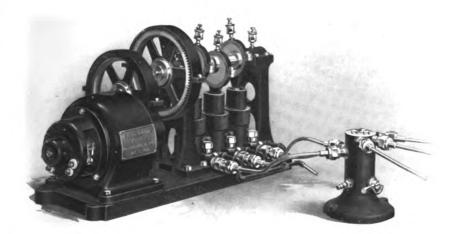


Fig I

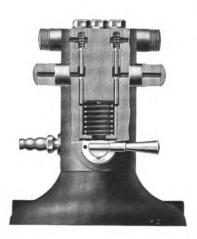


Fig. 2

HESE cuts show a motor-driven triple plunger pressure pump with the valves located in a separate chamber between the cylinder and the pump, and under the control of an operator in a position to see the progress of the work. The three plungers are mounted on one shaft at angles of 120 degrees. The pumps consist of a solid plunger working in a block and with a gland packing, connected by a copper tube with a valve-block, the details of which can be seen by Fig. 2. It will be noticed by this view that there are three valve chambers, each provided with a connection which leads directly to its own piston chamber, and that these valve bores are arranged in the shape of an equilateral triangle. A push-tube is used so that the valves may all be depressed from their seats at one time, but the upper valves are made of different lengths, to permit the throwing-out of one pump before the others. The operator, by turning the valve-handle, can therefore stop one pump or two pumps, and by pressing all three upper valves, stop all three pumps from effective operation. When the pressure is to be relieved, the valve handle is turned still further by the operator, which causes the longest valve to open the pressure valve below it, the intermediate length valve then opens the second valve, and finally the shortest valve opens its pressure valve. This not only allows the gradual reduction of pressure in the pressure chamber, but it reduces the effort required to open the valves. If desired, the chamber containing these valves can be attached directly to the cylinders. It is possible to arrange these valves to seat as shown, or they may be inverted. In fact the valves may be placed in any position. They may be located in a Y or coupling, which would be allowed to lie on the ground in any position.

Price of 2 horse-power pump with motor, net. Price of 5 horse-power pump with motor, net. Code, Celerity.

Cable Address: "Dudgeon"
Lieber's Standard, A1, ABC 5th Edition
Western Union and Private
Codes Used

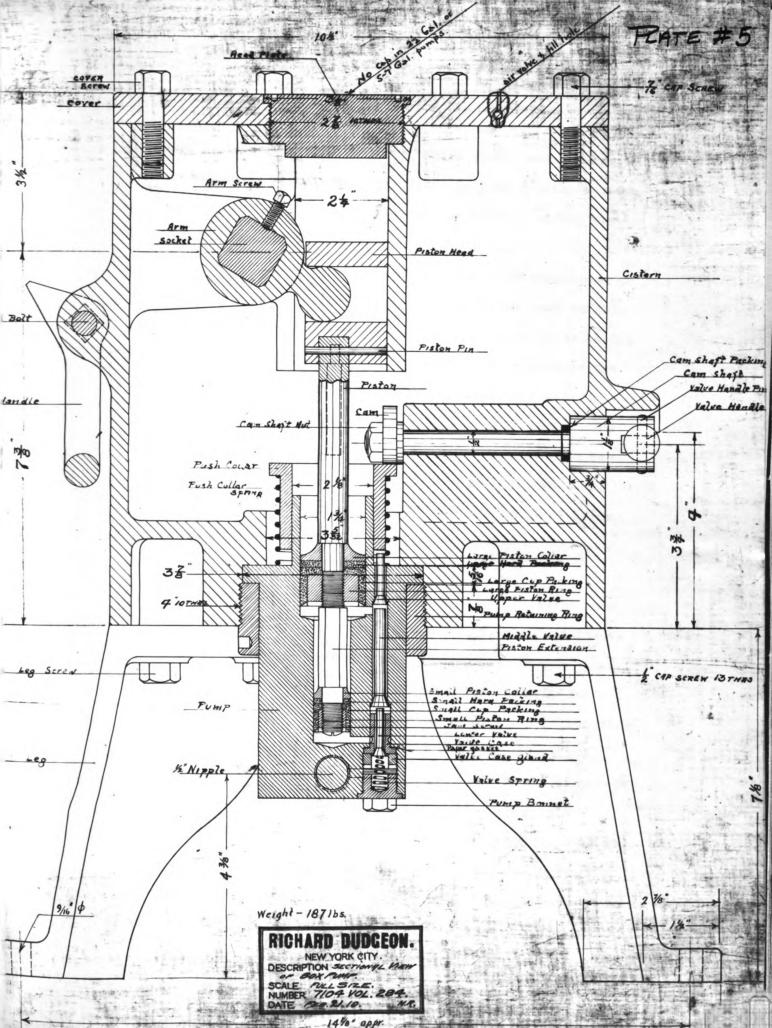
Richard Dudgeon

Columbia and Broome Streets, New York

Patented

Oct. 16, 1906 Sept. 22, 1908 Oct. 15, 1907 Nov. 24, 1908 Dec. 24, 1907 Jan. 12, 1908 Aug. 11, 1908 Mar. 2, 1908

Other Patents Pending



may be forced through the "tip" which when lighted forms an extremely hot flame. This flame is used for the cutting of the pipe sections and also for the cutting of the struts and jacking plates mentioned later.

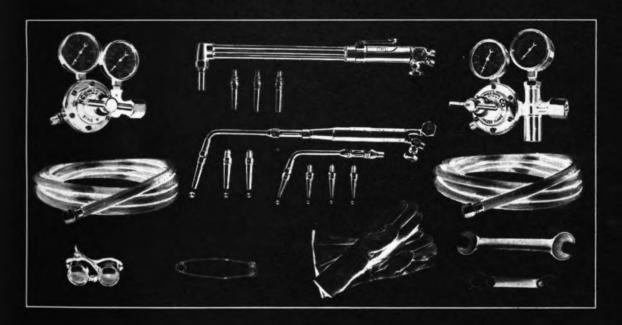
Plate Number 6 shows the acetylene torch manufactured by K. G. Welding & Cutting Company, which was used on this job. This instrument was used to cut 3" grout holes in the steel jacking plates, to cut I beam channel struts to the proper length to suit each individual case, and also to cut the 10" steel pipe casings to the proper length. The instrument must be accurate and must be equipped with the proper tip to make clean cuts. In the case of the steel pile sections, if a straight pile is to be obtained it is necessary that all cuts be made perpendicular to the axis of the pipe.

Plate Number 7 shows the diaphragm type of water pump which was finally used because of the particular conditions under which the men had to work. The 3" centrifugal shown on Plate Number 8 was used at the start of the job, and worked in a sump. It pulled through a considerable amount of foreign material because most of the time, it worked under no head. This pump was soon replaced by the diaphragm pump shown on Plate Number 7. The latter is a single open top diaphragm mounted on a steel derrick. Being of smaller capacity and more economical for this particular type of work it proved to be ideal for the job. The discharge from

PRATE #6

WELDING AND CUTTING EQUIPMENT

K-G Style "A-M" Welding and Cutting Unit



The last word in the very best two-torch welding and cutting unit. Any kind of welding or brazing operation can be successfully accomplished with the welding torch and up to and including ten inches can be cut with the No. 4 tip supplied with the unit. If you want the best there is and complete in every way the "K-G" Style "A-M" unit is what you should have. See complete details of welding and cutting torches on pages 4 and 8 and the regulators on page 12. The specifications are as follows:

Style "M-38" Cutting Torch with tips Nos. 1-4.

Style "A" Welding Torch, 2 mixers, 2 copper extensions and 7 tips.

Model "OW," "Waverless Flame" 2 stage, double gauge Oxygen Regulator.

Model "O" double gauge Acetylene Regulator

25 ft 3-braid corrupated green oxygen hose.

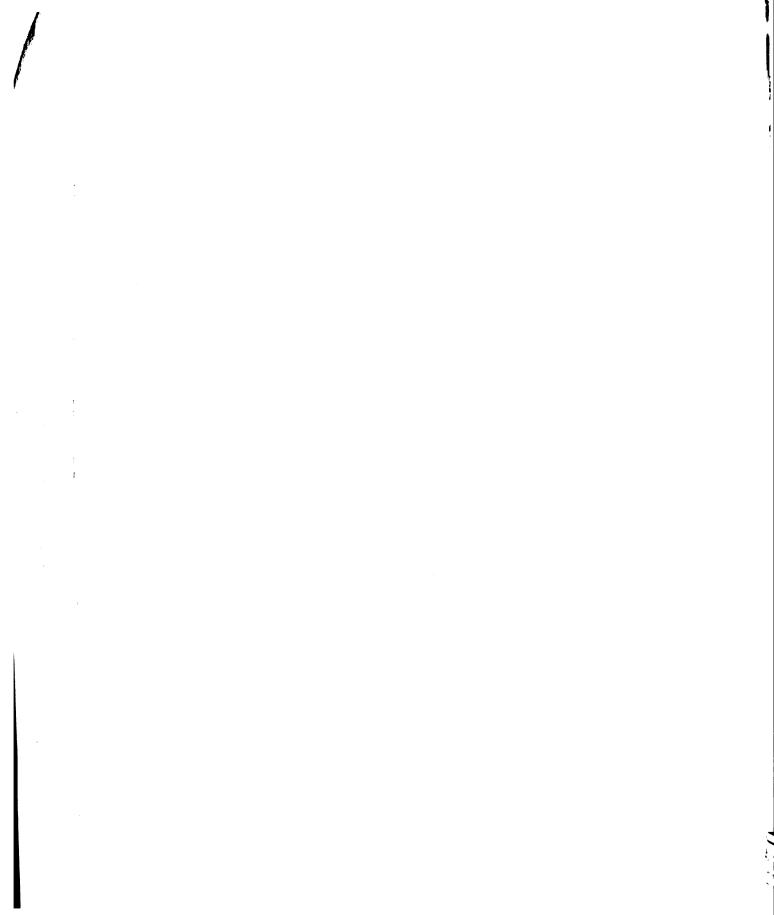
25 ft. 3-braid corrugated red gas hose.

Pair Goggles No. 6 shade.

Pair gauntlet wool-lined fireproof gloves.

Flint Lighter and tip.

2 Combination wrenches for tips, hose connections and regulators.



4 in. Double (open top) Diaphragm Pumps

PLATE#7



Fig. 1948. Model 21-0, Single, Open-top, Diaphragm Pump.

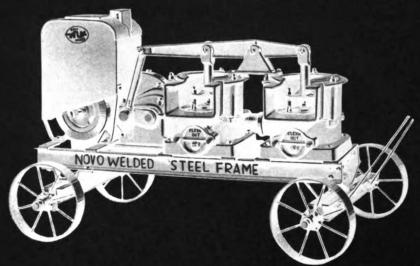


Fig. 1418. Novo 4" Double (open top)
Diaphragm Pump

Novo (open top) Single and Double Diaphragm Pumps are the standard units used for removing large quantities of water at low and moderate heads.

These pumps are built to give steady, trouble free service—to withstand the wear and abuse that a pump gets on the job. The horse power of the gasoline engine is above that required by the PUMP BUREAU, giving a large power reserve.

The reduction gear between the engine and pump is totally enclosed and flooded with oil.

The outfits listed below cover both single and double, four inch open top pumps. Triple-Life diaphragms used on all outfits. Standard mounting is a 4-wheel truck, also furnished skid mounted or pneumatic roller bearing wheels.

SPECIFICATIONS A. G. C. RATINGS

OUTFIT NO.	21-0	42-OA	42-OW 4" Double		
PUMP (OPEN)	4" Single	4" Double			
CAPACITIES: At 10' Suction Lift At 20' Suction Lift		12,000 G.P.H. 7,000 G.P.H.	12,000 G.P.H. 7,000 G.P.H.		
POWER UNIT Cooling	444	1 Cyl., 3½ H.P. Air	1 Cyl., 3½ H.P. Water		
WEIGHTS (SHIPPING): Skid Mounted 4 Steel-Wheel Truck 4 Wheel, Pneumatic-Tired, Truck	990 lbs.	1300 lbs. 1395 lbs. 1395 lbs.	1365 lbs. 1460 lbs. 1460 lbs.		
CODE WORDS: Skid Mounted 4 Steel-Wheel Truck 4 Wheel, Pneumatic-Tired, Truck 16" x 4"		SEXAM SEXEN SEXIO	SEXOL SEXUR SEXYZ		



pumps.

Novo Self-Priming Pump

15,000 Gallons Per Hour

Distinctly a favorite pump for sewer, bridge, general building, and pipe line contractor. Also, a transfer and loading pump for oil fields. Our standard Neoprene valves handle this type of work satisfactorily. Due to its larger clearances, it can handle muddier water containing

Besides being used for dewatering purposes, this pump is used for jetting work on some jobs on which it is usually hooked up in series.

more sediment than is possible with smaller

It is definitely out of the small pump class



Fig. 1963—Novo 15M Pump on skids.

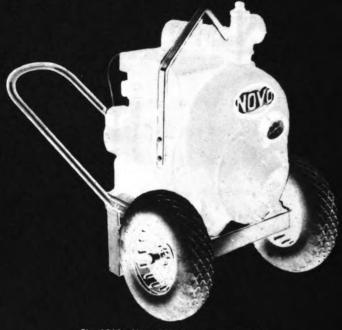


PLATE #8

Fig. 1962-Novo 15M Pump on pneumatics.

with its guaranteed capacity of 15,000 GPH. And yet, its design and light weight make it very portable.

The power unit is an air-cooled, industrial-type, 4 to 5 HP, Novo engine which insures ample power under all job conditions. Engine is anti-friction bearing equipped and has impulse coupling and throttling governor.

See electric and belt-driven pumps on Page 14. Pump standard with HOISTING BAIL, SUCTION STRAINER, VACUUM GAUGE, and TWO 14" x 31/2" STEEL or 14" x 4" PNEUMATIC WHEELS.

Specifications



				_	-	_	-	_	-	_	_		_	-	-					
NOVO MODE	L No																			KL3
POWER UNIT								4	_	5	H	P	, 1	1-	C	y I	.,	A	ir-	cooled
										3:	3	C	u.	h	n.	C)ii	60	la	cemen
SHIPPING WE																				
	on	skids																		395
CODE WORD	on steel	truck																	.1	APAI
	on pneu																			
	skid mo	unted																		APIT

The table has been adopted as a capacity standard by the Contractor's Pump Bureau of the Associated General Contractors of America, Inc., and sets forth the performance requirements under average job conditions for this size pump. We guarantee this pump o meet the A. G. C. Standards in every respect."

MODEL 15-M

TOTAL HEAD	HEIGHT OF PUMP ABOVE WATER											
FRICTION	10 ft.	15 ft.	20 ft.	25 ft								
20 ft.	250											
25 ft.	245	210	170									
30 ft.	235	205	165	130								
40 ft.	215	190	160	125								
50 ft.	185	165	145	120								
60 ft.	135	130	125	105								
70 ft.	65	65	65	60								

BULLETIN NO.

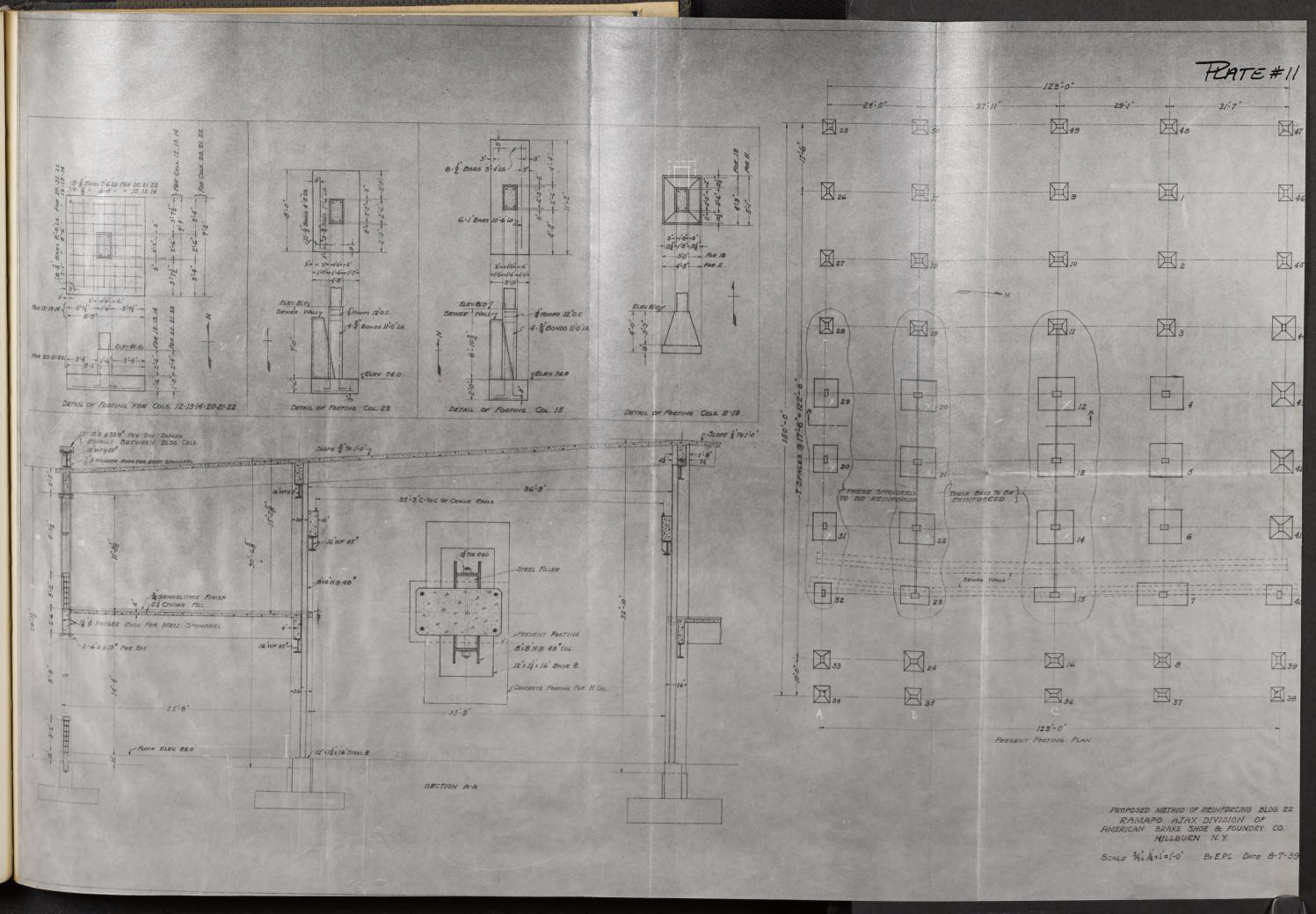
this pump was emptied into a chute which in turn discharged into the open drainage tunnel through convenient openings in the floor. This tunnel is indicated on Plate Number 11.

As will be noted, the tunnel runs entirely through the building, one wall of which combines with footings number 32 - 23 - 15 - 7 and 40. It was first thought that the excessive settlement of columns 5 - 6 - 7, 13 - 14 - 15, 21 - 22 - 23, 30 - 31 and 32, was caused by seepage through the walls of this tunnel.

Many times approach pits are above water and therefore no water pumps are needed. In this particular case however the bottoms of the footings were found not at an elevation of 5' below the floor line as indicated on Plate Number 11, but varied in depth from 8½' to 12' necessitating continuous pumping from the time the approach tunnel was started. It will be noted on Plate Number 11 that the elevation of the floor is indicated as 82.0 and the bottoms of the footings at 77.0. 1.

Jacking blocks, the use of which will be described

1. It might also be stated here that where approach pits extend to great depth, stage operation of pumps is necessary. Platforms are built at various levels and it is the job of each pump to lift the water from one stage or platform to the next. The amount of lift, of course, depends mainly on the efficiency of the pump and the quantity of water to be handled.



later, are generally 6" in diameter and are of steel pipe and any length from 6" to 2'. The ends are faced perpendicular to the axis of the pipe and the pipe them filled with concrete. The purpose of these blocks is to extend the run-out of the jack.

On the job referred to in this thesis an air hammer was used for speeding up the driving of wedges. Inasmuch as compressed air was available in the day time, a great deal of time was seved by transferring the load from the jack to the struts by the use of this medium. The one used was a standard Chicago Pneumatic fully illustrated on Plate Number 9.

In the under-pinning process we also have equipment which remains a part of the completed pile and thus is classified as material. One such item is the wedge, two sizes of which were used on this job. Both were 3" in width and 12" in length, one having a taper of 1/16" to 3/8", and the other 1/16" to 1/2". These wedges were made of steel and supplied by the R. Steel Construction Company, Long Island City.

The method of driving these wedges is generally by the use of a maul. The one used for starting the wedges weighed 10 lbs. A heavier maul would be used but for the fact the air hammer did the driving for transferring the load.

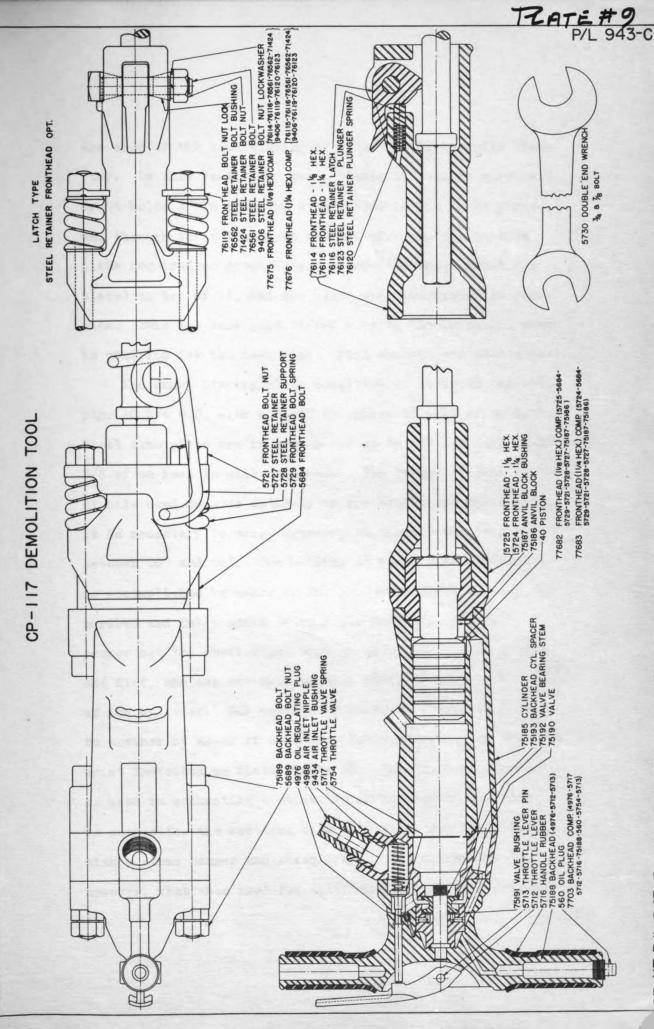
The steel jacking plates were square, 1" in thickness,



Chicago Pneumatic Tool Company

6 East 44th St., New York, N. Y.





CP-117 P/L 943-C THIRD EDITION (1000) NOV. 1938 PRINTED IN U.S.A.

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the side of the square being 4" in excess of the pile diameter. In this particular case, plates 14" square were used. Grout holes 5" in diameter were burned in the lower plates, and through these the grout was poured. The top jacking plate required no grout hole. A layer of thick grout was placed on top of it, and the plate was then mushed in position. This was done just before placing the hydraulic jack in position for the last time. Full contact was thus assured.

The under-pinning piles consisted of standard lap-weld pipe 10 3/4 0.D. with a shell thickness of 5/16 of an inch. Steel tube piles are in common use up to 16" O.D. and up to 3/8 of an inch in wall thickness. The length of each section of pile used depends entirely on the conditions under which it is necessary to work, however, in general the length is between 30" and 60". The cutting of these pile sections is accomplished by means of the acetylene torch already described and fully outlined on Plate Number 6. To make proper out the steel tubes must be clean, free from grease and dirt, and the cut must be made perpendicular to the axis of the cylinder. One section of steel tube pile is joined to another by means of a sleeve, fully described on the blue print indicated as Plate Number 10. This type of sleeve is used in connecting sections in under-pinning and also in connecting the sections of a pile which may be driven with a steam hammer and steam crane. The difference is, however, that when used for splicing pile sections driven

YOUNG CONTRACTING COMPANY

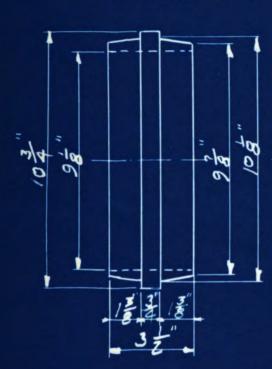
INCORPOBATED

HATE # 10

FOUNDATION DESIGN AND CONSTRUCTION
74 VARICK STREET, ROOM 205
NEW YORK, N. Y.

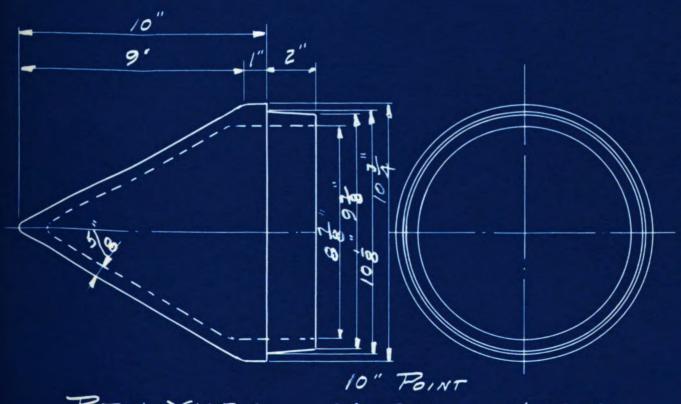
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DETAILS OF 10" POINTS AND SLEEVES, DEC. 1935.





10" SLEEVE PATT # Y 105 C.I. FOR UNDERPINNING PATT # Y 105 C.S. FOR PLE DRIVING



PATT # YIOP C.I.

YIOP C.S.

Y107 M.1.

by a steam hammer, the sleeve is made of cast steel so that it can withstand the terrific shock to which it is subjected. Inasmuch as there is no impact when the hydraulic jack is used the cast iron sleeve, which is much less expensive, may be used as a satisfactory method for connecting one section to another. The 10" sleeve used was $3\frac{1}{2}$ " in height, although larger sleeves of from 7" to 8" in height may be obtained. From Plate Number 10 it will be noted that the two insert sections are slightly tapered for ease in assembling the two sections of the under-pinning pile. The mid section acts as a shoulder so that the tremendous pressures to which the piles are subjected may be directed in a straight line from one section to another. Points are sometimes used on the first section of underpinning pile. The point used on this job for each of the under-pinning piles is fully shown on Plate Number 10. This plate shows the construction of the point and notes that it is made of cast iron. The insert section is identical with that of the sleeve. Points similar to the one shown on Plate Number 10 may also be made of cast steel or malleable iron. These two types are used when attached to a pile being driven by a steam hammer when boulders are encountered in the soil through which the pile must pass. The cast iron point would be easily broken under such conditions.

Concrete which is used for the filling of the under-

pinning pile may be of the usual mix, 1: $1\frac{1}{2}$; 3, or 1: 2: 4, or it may be of special mix, to suit the requirements of the engineer in charge of design. Aside from being used as fill for the under-pinning pile, concrete is also used for the encasement of the struts.

Struts are always of steel and generally of I beam or channel sections. The standard section of either of these two shapes may be used, and would range in depth of section from 6" to 12".

The example which the author has chosen to discuss in this thesis was done by the Young Contracting Company, Inc. of which he is the head. The reason for the choice of this job is that it was a typical one. The building, a machine shop, located in the Ramapo Valley at Hillburn, New York, is owned by the Ramapo Ajax, a subsidiary of the American Brake Shoe. It is of reinforced concrete and was built about twenty-five years ago.

The plan of the building showing the footing locations and also footing details is given on Plate Number 11, the columns under-pinned were 12 - 13 - 14, 20 - 21 - 22, 29 - 30 - 31. Plate Number 11 shows a section through the building indicating a mezzanine or balcony 14'4" above the floor in the south bay. This mezzanine floor was designed for storage of stock, and has a load capacity of 200 lbs. to the square foot. The crane bay, having a span of 35'3" center to center of crane rail, extends the full length of

the building or 150 feet. The width of the building is 123 feet. The floor is a 6" concrete slab and under the planers concrete bases are poured integral with the slab. The north bay has no balcony, but has several machinery beds for heavy equipment. There is no appreciable vibration in the north bay during the operation of the equipment. The condition in the south bay however is quite different, as much vibration is experienced when the large planers are in operation. The foundation for the building was originally a spread footing poured on a 3 foot slag fill over heavy river mud. The footings were designed for 1500 pounds per square foot. Settlement of this structure was noted almost immediately after its completion. In the past several years very careful and accurate settlement levels have been made by the owner. During the dry season very little settlement was noted. After heavy spring freshets, however, noticeable settlements were observed when readings were taken. amount of settlement on various columns ranged from 21" to 4". At the maximum point of settlement it was necessary to shim the crane rail to obtain the proper operation of this machine.

About a year ago the Ramapo Ajax decided to take bids from five contracting firms for the under-pinning or the arresting of the settlement of this structure. These five companies were asked to submit their own designs and prices

for the work. One of the general contractors called in was the Hunt Engineering Company of Teaneck, New Jersey. The Young Contracting Company was engaged to submit a design, method of procedure for the under-pinning, and price. The Hunt Engineering Company using this design and price, submitted it in the general contract to the Ramapo Ajax. Of the five designs submitted the one proposed by Young Contracting Company was selected and the Ramapo Ajax again called in the five contractors who had submitted the original designs and asked for a new figure on the Young design. The Hunt Engineering Company was awarded the contract, and in turn engaged the Young Contracting Company to do the under-pinning.

In October 1939 materials and equipment were placed on the job at Hillburn and the work started. Column number 22 adjacent to one of the heavy planer beds was the first to be under-pinned. Its location is indicated on Plate Number 11. Being an interior column it was necessary to start the approach pit by breaking through the concrete floor. When the first floor was penetrated it was found that there was another floor underneath. Also encountered below this second floor were sections of old planer beds. As there was no record of these changes throughout the twenty-five years of existence of the building, this condition was not expected.

The underlying material however caused but little in-

convenience, as an air hammer or demolition tool was used for breaking the concrete. This together with other excavated material was immediately removed to the outside of the building and placed in a storage pile. Later when the final column had been under-pinned this storage was used as backfill for that column. The reason for removing the excavated material from the first hole to the outside of the building was to permit the maintenance of traffic in the crane bay and throughout the entire building at all times. Material excavated from the succeeding holes was used as back fill for the first and so on, thus it is obvious that at no time were large quantities of excavated material lying on the floor to hamper the machinists in their work. As the vertical approach pit was excavated 6' in width and 8' in length and to a depth approximately 6' below the footing, a great deal of water was encountered. Reference has already been made to the fact that the elevation of the bottom of the footings was considerably below the points indicated on the plans, and therefore, the complete operation of the under-pinning of this and all remaining columns was below the water line. Among the materials excavated from this vertical approach pit were fill, blast furnace slag, and heavy river mud.

On column number 22, as well as column number 12 there were cantilever cranes which the owner permitted the contractor to use in the excavating of approach pits and approach

tunnels. These cranes in hauling out the mud buckets from below saved a great deal of time in the excavating. Buckets were lowered into the pit, filled by the excavators working below, and then were lifted by means of the crane and dumped directly into wheel-barrows.

On the completion of the vertical approach pit, the horizontal approach tunnel was started. It was 6' in width and approximately 6' in depth below the footing, and extended under the footing to a distance of 7'. The material excavated in this horizontal approach tunnel was blast furnace slag and foreign material, such as tree stumps and railroad ties.

Because of the fact the operation was so far below water level it was necessary to sheet the approach pit and the approach tunnel simultaneously as the excavating proceeded. The sheeting consisted of 3"x8" tongue and groove planks and was held in place by 6"x6" wales. The wales were placed approximately 4' apart or at the top and bottom of the sheeting and properly braced, thus leaving ample room for the workmen using the hydraulic jacks. The sheeting was set and driven by means of a pneumatic hammer as the excavating continued. It was necessary during the entire operation to pump continuously, and while centrifugals were used at first, it was found much to the advantage of the excavators to use the diaphragm pump already described.

As the excavating in the approach tunnel progressed

underneath the concrete footing, it was deemed advisable to place mud sills 10"x10" in size and 6' in length underneath the edge to insure the safety of the workers. These mud sills were of long leaf yellow pine. Above them were placed 10"x10" struts approximately 5' in length. were also of long leaf yellow pine, and were secured with oak wedges under the concrete footing to prevent sudden slides or settlement of the footing. The oak wedges used were 2" in width and 8" in length and tapered from 1/2" to $1\frac{1}{2}$ ". To minimize the amount which they might be caused to settle on the insertion of the wedges, these mud sills were mushed into place before the placing of the struts. Once the mud sills and sheeting were in place, the top wale was braced to the bottom one and used for the support of a platform large enough to accommodate the hydraulic pump and its two operators. At no point was the depth of our excavation in excess of the lift of the suction pump and therefore it was placed at floor level.

The foreman now selected the point for the first pile.

Once this was determined, a crib approximately 2' x 2' was
excavated at that point to give an added 16" in length on
the pile section. This crib was made of 8" x 1" shiplap.

Its interior was cleaned of all material and the first
section of pile, approximately 4'6" long with the point in
place, was set. It might be noted here that the sump for
the diaphragm pump was excavated sufficiently below the two

foot square crib to completely drain this crib, and to permit working "in the dry".

The jacking plate was next placed on the top of the pile section, the hydraulic jack, in its depressed position placed upon the plate, and another jacking plate put on top of the jack and resting immediately underneath the concrete footing. This footing had been sufficiently smoothed off to insure a full bearing on the top jacking plate. The pile length was so figured as to occupy all space available in this assembly and is clearly shown on Plate Number 12. The hydraulic pump was then connected to the jack by means of flexible copper tubing. The gauge for reading pressures to be exerted on the footing was installed, and the pumping started.

When the run-out of the jack was completed, the jack was collapsed and jacking blocks placed above the jack head. The top jacking plate was then replaced and the jacking operations continued. When the run-out of the jack was again completed, another section of jacking block was placed and the operation continued until the top of the pipe pile was on the level of the bottom of the crib. At this point a sleeve, a new tube section, the jacking plate, the depressed jack, and then the top jacking plate were put into position in the order named. All the while, continuous pumping of water was necessary. This procedure was continued until the readings on the gauge indicated the

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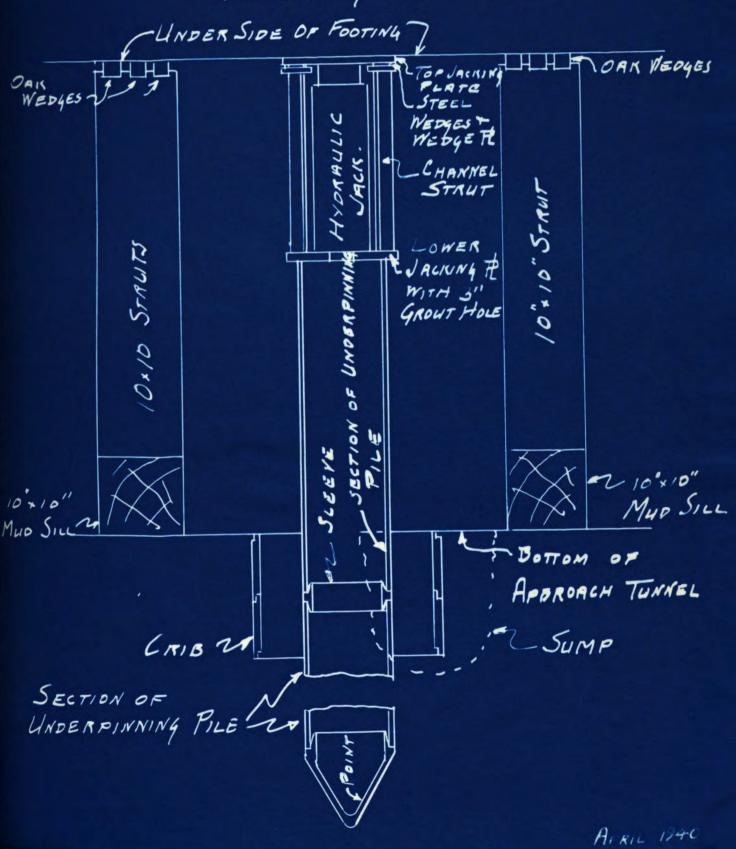
PLATE # 12

FOUNDATION DESIGN AND CONSTRUCTION 74 VARICK STREET, ROOM 205

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WALKER 5-2936

SECTION THROUGH ASSEMBLY OF UNDERPINNING UNIT



designated load of 30 tons (for which these piles were designed) plus a 50% overload.

Another column was now started, and observations were taken every hour for about three hours on the gauge reading for the pile just completed. When the gauge indicated a settlement the pump was started again until the 45 ton load (30 tons plus 50% overload) was obtained, after which further observations were made. When it was definitely established that the point had been reached where no further settlement would be obtained under the given load, the jack and the plates were removed and concrete was poured in the pile filling it within two inches of the top.

When the concrete had settled, the jacking plate with the grout hole was again placed in position. Grout was poured through the 3" hole, and the plate was carefully mushed to position on the top of the tube to insure complete contact. The jack was again replaced and the jacking plate placed on the top of the jack (and under the footing). The pressure was again applied and readings were taken as above. At this point it should be noted that the "spring back" of the pile was eliminated. When no further settlement was indicated, two 8" channel struts were placed, one either side of the jack. These struts had been cut to the proper length to fit between the upper and the lower jacking plates with only sufficient clearance on the ends to permit placing of the steel wedges for transfer of the

load.

The steel wedges were assembled in triplicate for added power and placed between the top jacking plate and the ends of the struts. The maul was used to start the driving, and when the wedges became tight the air hammer was placed in service. During the driving readings were constantly taken on the gauge indicating the lowering of the load on the jack as this load was transferred to the struts.

The driving continued until the reading on the gauge became zero. Were the jack collapsed before complete transfer of the load had been made, the pile would tend to spring up again, and upon final transfer of the column load on all piles, further settlement might be experienced. This is one of the most important points to be observed in the under-pinning process.

As the main column loads were computed to be 120 tons, it was necessary to place three more piles under this footing in a like manner. When the column load was completely transferred, all equipment was removed from the hole, including the sheeting and the platform. In order to obviate slides, the sheeting was removed as the back filling took place. When the back fill reached a point one foot below the top of the under-pinning piles, a dam was placed in the approach pit, at the entrance of the approach tunnel. Concrete was forced behind this dam and sufficiently puddled

to completely fill the excavated section underneath the column footing. Obviously, the thickness of concrete at this point was the one foot just referred to plus the full length of the struts. The length of these struts must be not less than the height of the collapsed jack plus 2", and not more than the height of the open jack plus wedge clearance. When the concrete encasement of the struts was completed the hole was backfilled to the underside of the concrete floor. This backfill was tamped and used as the bottom form. Concrete was then poured and finished to match the floor.

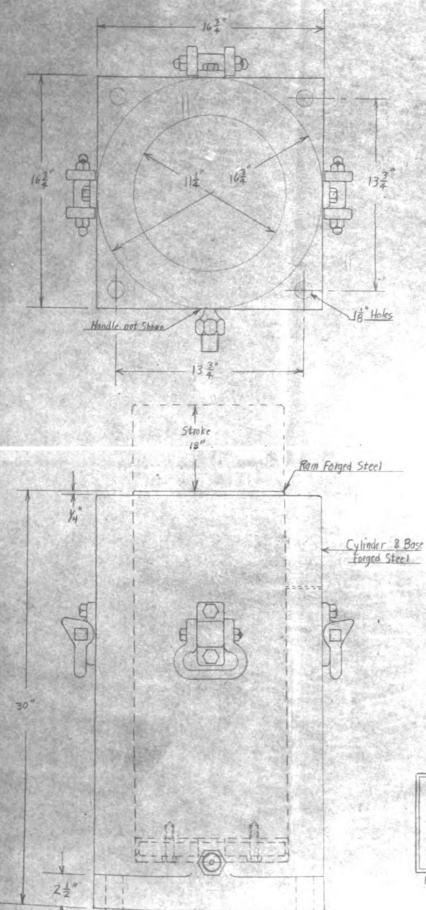
Upon the completion of all of the columns which were done in a similar manner, settlement levels were taken from points on these columns which had been referred to a datum set outside of the building. Not one of the nine completed columns under-pinned gave the slightest evidence of settlement.

When the job was finished 432 feet of under-pinning pile had been installed in a total time of 31 days. Each day averaged eight hours, with six mem working. Prior to the advent of this method of under-pinning, such a job would have cost many thousands of dollars more and would have required double the time to complete. All this without the positive assurance that no further settlement would be experienced. Furthermore, under the old method it would have been necessary to close the plant during the complete time

of this operation. With the new system, no inconvenience whatever was experienced by the operators of the heavy planers and other machinery in the building, during the installation of the piles. Then too, under the old system, it also would have been necessary to shore up each column before starting the under-pinning. This would have involved additional expenditures of time and money.

Methods have advanced considerably since 1900, and improvements can still be made, especially in the construction of the hydraulic jack.

It is the author's opinion that the general manufacture of under-pinning jacks having bases equipped for the attachment of I beam clamps (the manufacturer also supplying these clamps) would greatly increase the adaptability of this machine. Plate Number 13 shows one of the heavier jacks with a square base such as might be recommended for the lighter under-pinning jacks, and to which the I beam clamp could be adapted. By means of this clamp the jack could be attached in an inverted position to an I beam which would take the place of the top jacking plate referred to. This I beam could be of any length to suit conditions and could be held against the under side of the footing by means of struts. This would result in the saving of all the time now lost in the removal and re-setting of the instrument after the installation of each section of pile. It would be necessary only to depress the jack by means of an hy-



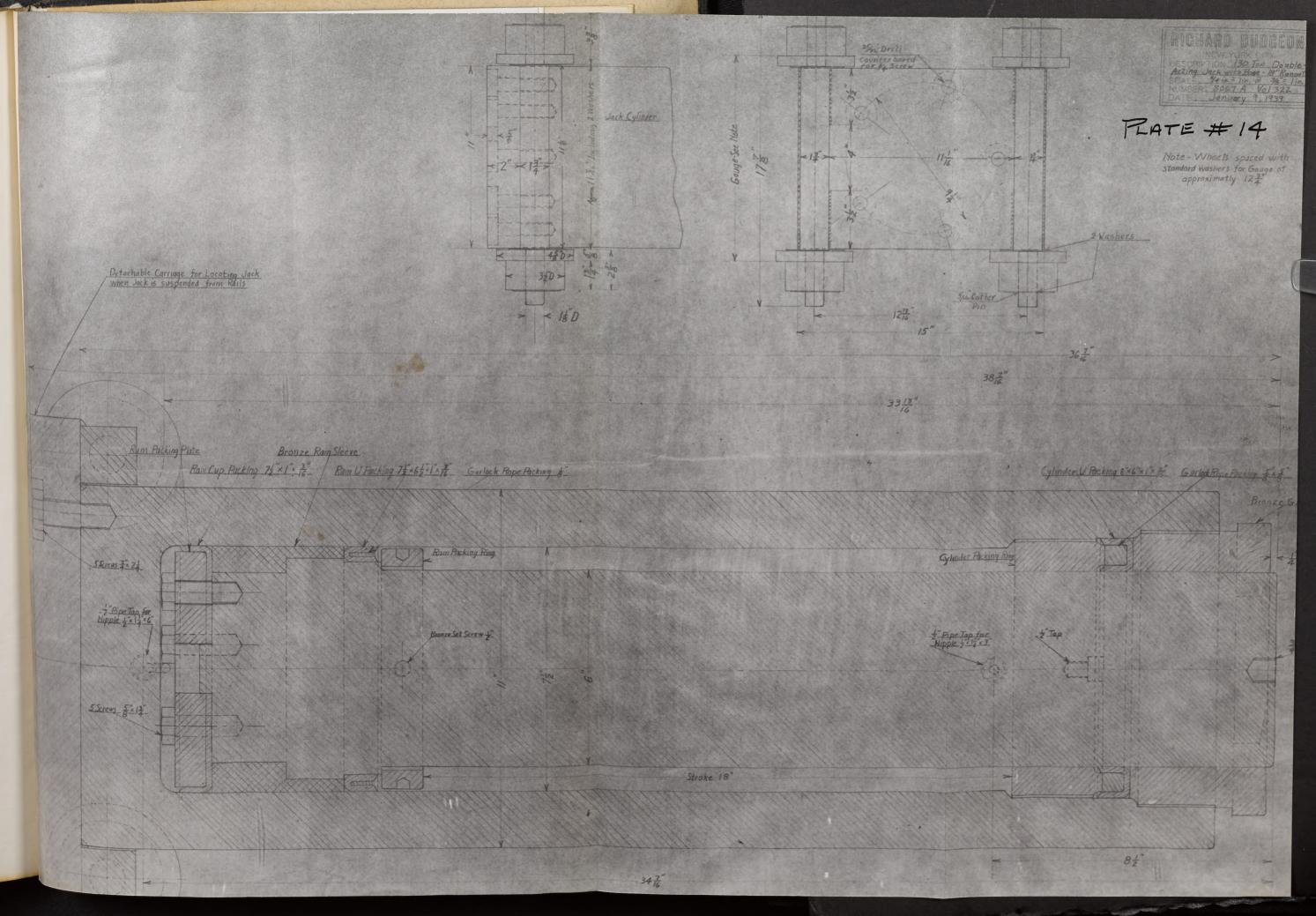
Weight 120016

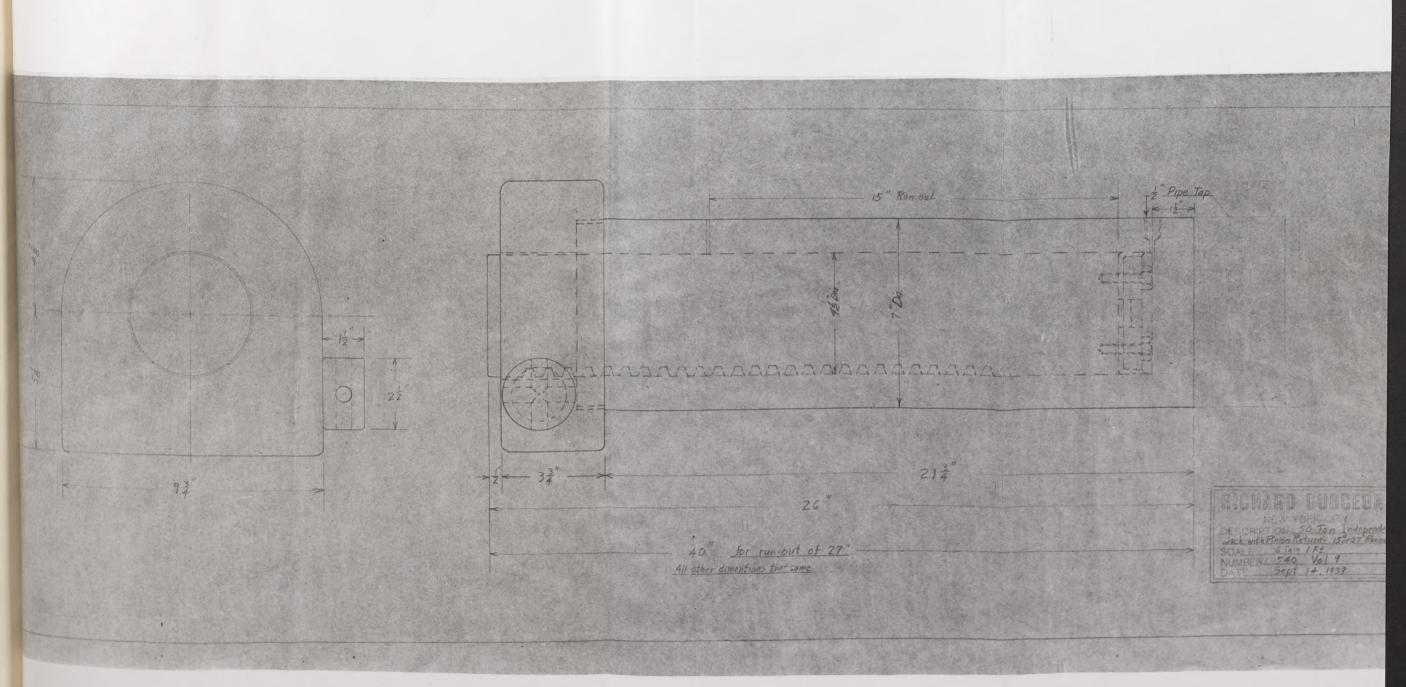
NEW YORK CITY
DESCRIPTION 300 Ton Indep
Type Jack 18 Stroke
SCALE 3 in 1 | Ft

Revised 4 10-40 To show it

Mumber 14, or a rack and pinion, such as is shown on Plate Number 15, and insert the next section to be installed. Then, to extend the run-out of the jack, it is necessary only to add the jacking blocks before proceeding with the pumping operation.

Contrasting this with the present method which requires the complete removal of the heavy jack after the driving of each short section of pile, and remembering that the improvement suggested by the author will eliminate the handling of the 287 pound machine in limited quarters, it is obvious that this improvement will cut the actual operating time in half, and will reduce costs by at least 25%.





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