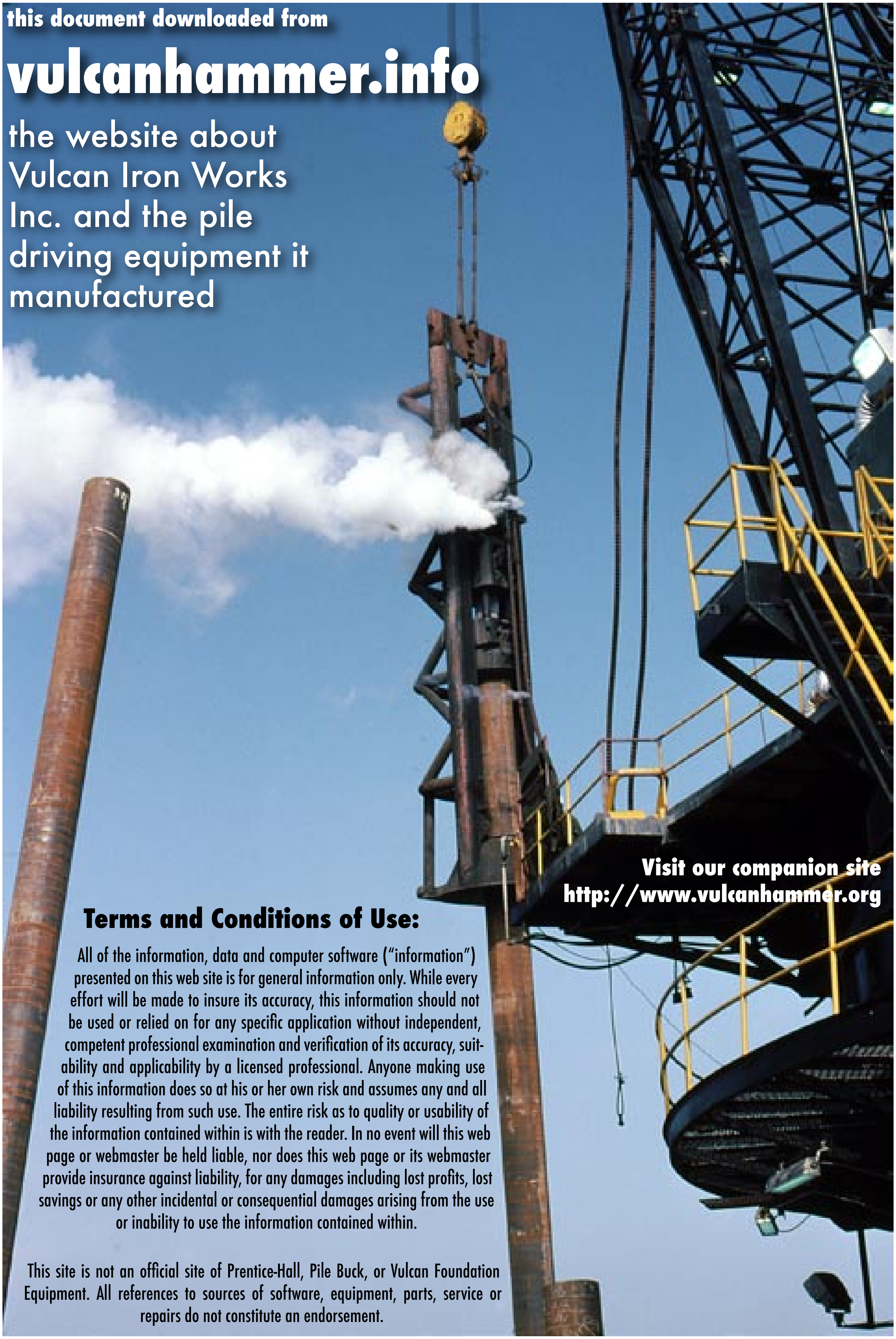


PILE DRIVING ANALYSIS SHEET

* please read INFO SHEET.
* use seperate sheet for each case.
* processing only when completely filled in.
* this sheet, completed with output will be returned to client.

1. INPUT BY CLIENT.

client = ______________________.
clients code = ______________________.

1.1 HAMMER: Make = ______________________. Type = ______________________.

1.2 PILE : (incl.followers)

top of pile →

Total pile length = ______ m.

Penetration below mudline = ______ m.

pile parts (m)		O.D.	I.D.	area (cm^2)
parts	length			
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

1.3 Soil : soil investigation by = ______________________.

mudline →

(1 ton =1000 kg)

soil layers (m)		skin friction (ton/m) varies between ...... and ...... ①		type of soil
from	to			
0				

damping factor for skin friction ② = ______ sec/m. (o.6 unless client states differently).
fixed plug supposed to be formed ③ = ______ (yes or no).
unit-endbearing 3 = ________ ton/m^2.

(Notes ① - ④ : see INFO SHEET)

2. OUTPUT SUPPLIED TO CLIENT.

2.1 set per blow = ________ cm. blowcount = ________ blows/ft.
2.2 net hammer energy at impact = ________ ton.meter.
2.3 buffer force = ________ ton. (for Hydroblok hammers only).
2.4 total skinfriction = ________ ton. ④
2.5 endbearing = ________ ton. + ④
2.6 total driving resistance = ________ ton. ④
2.7 dynamic stresses in pile (kg/cm^2: σ_{min} = ________. σ_{max} = ________.

price:

hydroblok hollandsche beton maatschappij bv
p.o.box 82 - rijswijk - the netherlands.

INFO SHEET (Info to "Piledriving Analysis Sheet")

This information is to assist clients filling in all questions under the heading INPUT of the standard "Piledriving Analysis Sheet".

We must apologize in anticipation for not being able to process incomplete forms; they contain the bare minimum of information needed for a first quick analysis.

In many cases a concise analysis along these simple lines will be inadequate. We are prepared to go more deeply into detail in specific problems, if the client wishes so, though we than have to agree upon different terms and conditions in advance.

Problems may arise concerning a proper input from clients side, in the way it is needed for simple standard computer processing. For clients convenience therefore examples are given in this Info Sheet concerning pile-input and soildata-input.

On a few points suppositions have to be made as for instance whether a fixed plug will form during driving or not; we deliberately ask the client to give his view concerning certain assumptions that must be made. This concise analysis does not allow for a thorough investigation on crucial points, as for instance "plug-forming".

Concerning pilecap, anvil and capfilling manufacturers standards are incorporated in our computer programs. If the client wishes to have non-standards to be incorporated in the analysis he should supply relevant information, preferably a dimensional sketch and a specification of the capfilling material.

"Pile Driving Analysis Sheets" completed with the output of the analysis will be returned to the client.

Clarification on the 4 notes of the "Piledriving Analysis Sheet":

Note ① Basic Value of Skinfriction

The basic value of the skinfriction is equal to the product of unit skinfriction (metric tons per sq.meter) and circumference of pile (meter).

If inside friction is to be expected (open ended pile with soil plug moving relative to pile) the basic skinfriction is equal to the sum of unit outside skinfriction muptiplied with the outer circumference plus unit inside skinfriction multiplied with the inner circumference.

Basic skinfriction may have discontinuities at the boundaries of the soil layers. The Analysis Sheet table provides for this. Within each layer a linear distribution of the skinfriction is assumed in the analysis.

INFO SHEET

Note ② Dampingfactor.

The skinfriction is assumed to depend on the velocity of the pile (as a function of depth and time) according to the formula:

$$W = (\text{sign of } v).\ W_o \ (1 + \alpha |v|)$$

with v = velocity of pile; $|v|$ = absolute value of v

W_o = basic skinfriction

α = damping factor (ranging from 0,25 - to 0,60 sec/meter)

W = acting skinfriction

α depends on nature of soil and degree of consolidation.

If α is not known α = 0.6 sec/m will be used automatically in the analysis.

Note ③ Plug and Unit-Endbearing.

When an open-ended pipe pile is driven, a certain quantity of soil will enter into the pipe; the "soil plug" or "plug".

When driving either of two possible conditions may occur:

a) the plug moves into the pile.

b) the plug is fixed i.e. the plug moves downward with the pile: the pile behaves like a pile closed at its toe.

Remark I The condition b) "fixed plug" during driving is not the same as the condition "fixed plug" for static loading. Often the plug will move into the pile (condition a). Even when a static analysis shows the fixed plug possibly to form, this plug might move into the pile (condition a during driving).

In cases of doubt it is suggested that pile driving analyses are to be made for both cases: a)"moving plug"
b)"fixed plug"

(seperate "Analysis Sheet" per each case!)

Remark II Unit internal skinfriction generally has a lower value than unit external skinfriction. (say $\frac{1}{4}$ to $\frac{1}{2}$)

Remark III. As a guidance for the unit-endbearing the following values may be assumed:

sands 100 x unit-skinfriction at pile toe
clays 30 x " " " " "

(Values given by soil consultants may supersede these indications).

These values may be used as such for condition a) (plug moving into pile).
For condition b) (fixed plug) these values apply only if pile toe has penetrated sufficiently into a uniform hard layer.
If not, the unit-endbearing in this case reduces to a value depending on penetration into hard layer and on the strength of layers on top of this hard layer (reduction up to, say, 1/3 of values given).

Note ④ Total skinfriction and total endbearing and total driving resistance are calculated with the data supplied by client. (These values may be checked by client).

Remark = Total driving resistance need not be equal to total static resistance.

References: 1 De Ingenieur, no. 8, 21 Febr. 1974, pages 146-153.
2 De Ingenieur, no. 18, 2 May, 1974, pages 345-353.
3 1976 OTC, Houston, no. 2477, pages 593-609.

INFO SHEET

1. Conversion factors For input (foot-pound units to metric units)

Length, area, volume
1 ft = 0,305 m
1 inch = 0.0254 m = 25.4 mm
1 sq ft =0.093 sq.m = 0.093 m^2
1 sq.in. = 6.45 sq.cm= 6.45 cm^2
(1 cu.ft = 0.02837 cu. m = 0.02837 m^3)

Forces, weights
1 ton = 1 metric ton = 1000 kg
1 (long)ton (2240 lbs) = 1017 kg ≈ 1 metric ton
1 (short)ton (2000 lbs)= 908 kg = 0.908 metric ton.
1 kip = 0.454 metric ton

Stresses and pressures.
1 ksf = 4.88 t/m2 = 4.88 metric tons per sq.m.(use for conversion of Unit skinfriction and Unit endbearing.
1 (long)ton/sq ft.= 10.93 t/m2

Skinfriction.
1 kip/ft = 1.49 t/m
1 (long) ton/ft = 3.33 t/m
Skinfriction asked for in 1.3 is unit skinfriction – circumference of pile (eventually outside and inside together).

Damping factor for skinfriction
1 sec/ft = 3.28 sec/m 0.6 sec/m = 0.183 sec/ft

Velocities(eventually)
1 ft/sec = 0,305 m/sec

2. For Output (metric to ft-pound units)

1 cm = 0.394 inch

1 ton meter = 7222 ft lbs

1 ton = 2202 lbs = 2.202 kips

1 ton = 0.983 long tons

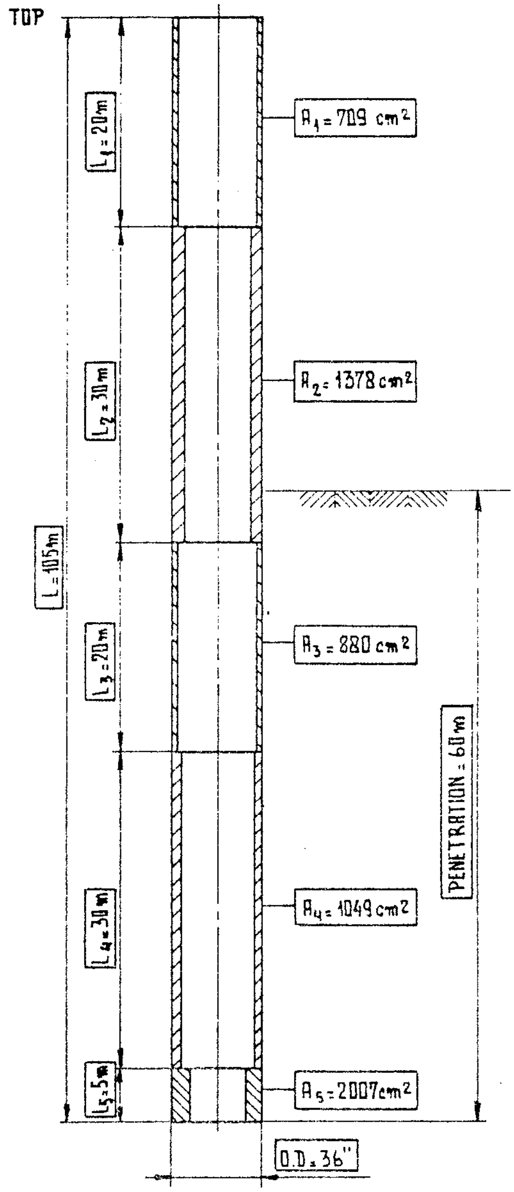
1 ton = 1.103 short tons

1 kg/cm2 = 1 kg/sq cm = 14.21 psi = 2.046 ksf.

PILE : EXAMPLE

[FICTITIOUS]

PILE INCLUDING FOLLOWER



1.2. PILE : (incl.followers)

top of pile →

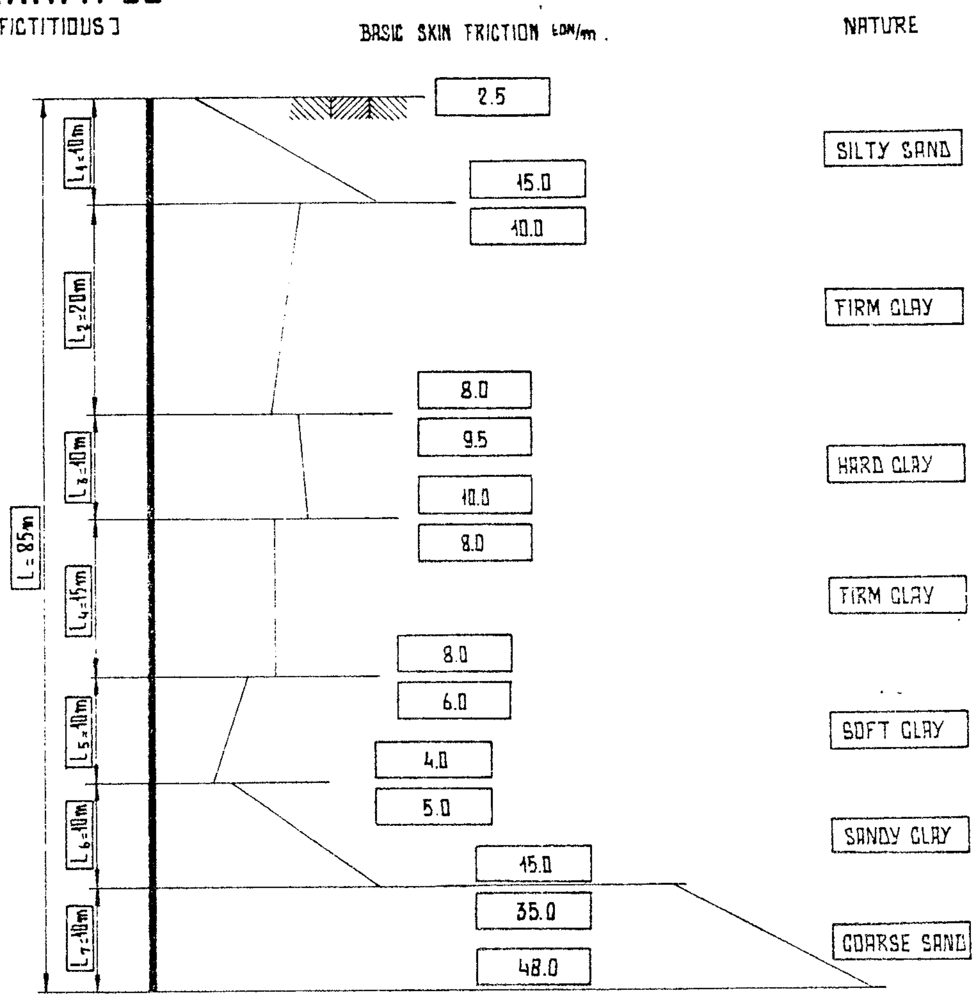
total pile length = 105 m.

penetration below mudline = 60 m.

pile parts (m)		O.D.	I.D.	area (cm^2)
parts	length			
1	20.00	36"	34"	709
2	30.00	36"	32"	1378
3	20.00	36"	33.5"	880
4	30.00	36"	33"	1049
5	5.00	36"	30"	2007
6				
7				
8				
9				
10				

SOIL : EXAMPLE

[FICTITIOUS]



1.3. SOIL : soil investigations by = COMPANY XYZ.

mudline →

(1 ton=1000kg)

soil layers(m)		skin friction(ton/m) varies between		type of soil
from	to	...... and ...... ①		
0	10	2.5	15.0	SILTY SAND
10	30	10.0	8.0	FIRM CLAY
30	40	9.5	10.0	HARD CLAY
40	55	8.0	8.0	FIRM CLAY
55	65	6.0	4.0	SOFT CLAY
65	75	5.0	15.0	SANDY CLAY
75	85	35.0	48.0	COARSE SAND

damping factor for skin friction ② = 0.5 sec/m.(0.6 unless client states differently).

fixed plug supposed to be formed ③ = NO (yes or no).
unit end-bearing ③ = 700 ton/m2

(Notes ① - ④ :(see Info Sheet)

Verolme

Verolme Machinefabriek (Engineering Company) IJsselmonde B.V.

STASSI
TO KASTNER
N.O.

McDermott Servicios de Construcoa Ltd.
att.Mr.Fred Thomason
Rua Mexico 31 - Grupo 501
20.000 RIO DE JANEIRO. R.J.Brasil

RSV

Re — Your ref. — Our ref. vHu/cm — Rotterdam, 8th February 1979

Dear Mr. Thomason,

Subject: Demonstration with Hydroblok HBM 4000 piledriving hammer February 22, 1979.

As published worldwide last year in offshore magazines two HBM 4000 piledriving hammers were ordered for delivery by the end of 1978. These hammers are the most powerful among presently proven ones. The initial full scale testing meanwhile has confirmed that the rated energy output measured on the testpile goes far in excess of the 1,700,000 specified feet-lbs. The number of blows reached was 80 per minute.
For particulars we refer to the attached sheet.

The above testing of the hammers happens in combination with a 4400 HP hydraulic powerpack which has been built especially for their drive, At clients' demand it is a skid mounted, containerised and fully self sustained unit.

The HBM 4000 hammers are now striking their testblows on top of an 84 in. O.D. 1:5 batter testpile. This testpile passed a dense sand layer at 225 feet depth which caused a temporary refusal of 25,500 blows/foot. At the time this letter was written, the hammers have been driving over 29 hours. ?

We are now organising a demonstration of the piledriving capabilities of the above Hydroblok hammers on Thursday, February 22, 1979, for which we gladly invite you.
This demonstration is set up in cooperation with the future Owners.

The program is as per attachment.

Our guests are invited to assemble on the 22nd of February at 09.15 hrs a.m. in front of the Rotterdam Hilton Hotel, located in the very centre of the city.
From there transport will be arranged by buses.
In case you prefer to have your own transportation, we advise that our presentation will start at Motel "Papendrecht", Restaurant "De Staatse Schans" on the first floor.
This place can easily be found at the freeway entrance of the town of Papendrecht.
For your easy reference you will find enclosed herewith copy of a map of the pertaining Rotterdam-Papendrecht area.
By road, the distance Rotterdam-Papendrecht is approx. 20 miles.

Due to short time available we kindly ask you to confirm your attendance by telex or by telephone, please ask for Miss Janet Visser.

It will be a great pleasure to have you as our guests on February 22, 1979.

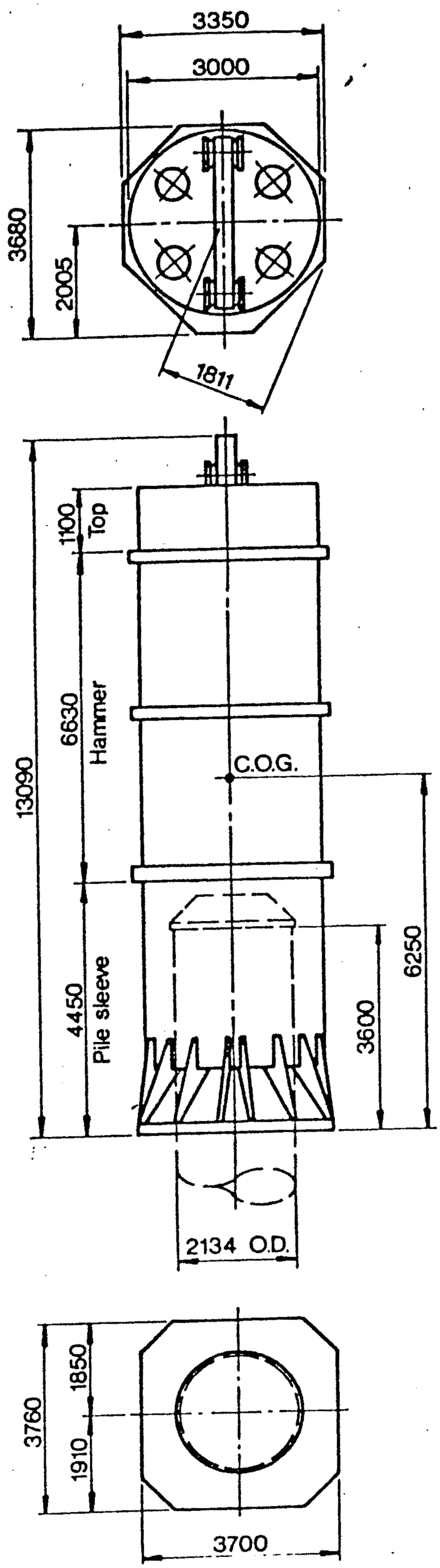
Yours faithfully
VEROLME ENGINEERING COMPANY
IJSSELMONDE B.V.

G.J. van Hussen

Encl. 3 x

Hydroblok Hammer

Type : HBM-4000
Standard



Main Specifications.

CAPACITY

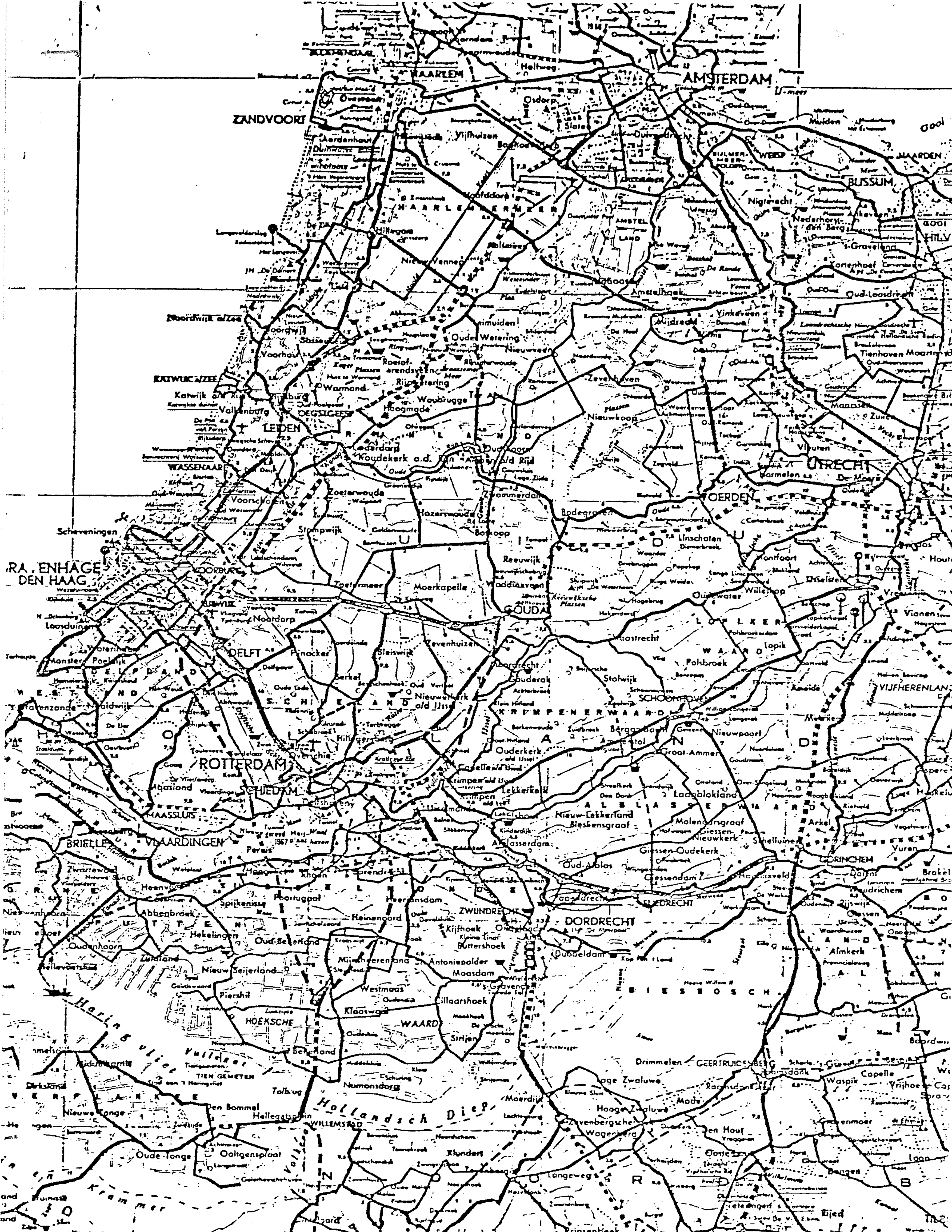
Guaranteed NET driving energy	160 tm. *1 200 000 ft lb*
RATED driving energy approx.	232 tm. *1 700 000 ft lb*
Bufferforce min.	1600 t. *3 300 kips*
max.	4000 t. *8 800 kips*
Number of blows/min.	40-70
Power (installed)	4400 hp.
Magnitude of total soilresistance the hammer can overcome during driving	7200 t. *16 000 kips*

WEIGHTS

Dropweight	93 t. *205 000 lbs*
Hammer (incl. drop-weight, excl. anvil, pile sleeve and ballast)	186 t. *411 000 lbs*
Anvil	15 t. *33 000 lbs*
Pile sleeve	21 t. *46 000 lbs*
Under water ballast	38 t. *84 000 lbs*
Max. pile size (without adaptor)	2134 mm. O.D.

Dimensions in mm. Subject to modifications.

0400-00-66



HAARLEM
AMSTERDAM
ZANDVOORT
Aerdenhout
Vijfhuizen
Osdorp
Sloten
Halfweg
Muiden
NAARDEN
BUSSUM
Nigtevecht
Nederhorst den Berg
Ankeveen
's-Graveland
Kortenhoef
Hoofddorp
HAARLEMMERMEER
Hillegom
Nieuw Vennep
Lisse
Aalsmeer
Amstelhoek
Uithoorn
Vinkeveen
Mijdrecht
Oud-Loosdrecht
Tienhoven
Noordwijk a/Zee
Noordwijk
Sassenheim
Voorhout
Leimuiden
Oude Wetering
Nieuwveen
Roelofarendsveen
Rijpwetering
Warmond
Woubrugge
Hoogmade
KATWIJK a/ZEE
Katwijk a/d Rijn
Rijnsburg
Valkenburg
LEIDEN
OEGSTGEEST
Leiderdorp
Koudekerk a.d. Rijn
Alphen a/d Rijn
Zegveld
Nieuwkoop
Zevenhoven
Maarssen
Vleuten
UTRECHT
WASSENAAR
Voorschoten
Zoeterwoude
Hazerswoude
Zwammerdam
Bodegraven
WOERDEN
Scheveningen
Stompwijk
Boskoop
Linschoten
Montfoort
IJsselstein
's-GRAVENHAGE
DEN HAAG
VOORBURG
RIJSWIJK
Zoetermeer
Moerkapelle
Reeuwijk
Waddinxveen
GOUDA
Oudewater
Willeskop
Vianen
Loosduinen
Nootdorp
DELFT
Pijnacker
Zevenhuizen
Haastrecht
Polsbroek
Lopik
Monster
Poeldijk
Wateringen
Bleiswijk
Moordrecht
Stolwijk
SCHOONHOVEN
VIJFHERENLANDEN
's-Gravenzande
Naaldwijk
Berkel
Nieuwerkerk a/d IJssel
KRIMPENERWAARD
Bergambacht
Ammerstol
Nieuwpoort
Groot-Ammers
Hillegersberg
Overschie
Ouderkerk a/d IJssel
ROTTERDAM
SCHIEDAM
MAASSLUIS
Capelle a/d IJssel
Krimpen a/d IJssel
Krimpen a/d Lek
Lekkerkerk
Langerak
Nieuw-Lekkerland
Bleskensgraaf
Molenaarsgraaf
Giessen-Nieuwkerk
Arkel
BRIELLE
VLAARDINGEN
Pernis
Alblasserdam
Giessen-Oudekerk
Schelluinen
GORINCHEM
Oud-Alblas
Giessendam
Hardinxveld
Zwartewaal
Heenvliet
Hoogvliet
Rhoon
Barendrecht
Heerjansdam
Poortugaal
Spijkenisse
Abbenbroek
Heinenoord
ZWIJNDRECHT
Papendrecht
SLIEDRECHT
DORDRECHT
Woudrichem
Giessen
Oudenhoorn
Hekelingen
Oud-Beijerland
Kijfhoek
Oostendam
Puttershoek
Dubbeldam
Almkerk
Nieuw Beijerland
Mijnsheerenland
St. Antoniepolder
Maasdam
's-Gravendeel
Piershil
Westmaas
Cillaarshoek
BIESBOSCH
HOEKSCHE WAARD
Strijen
Klaaswaal
Haringvliet
Drimmelen
GEERTRUIDENBERG
Raamsdonk
Waspik
Capelle
Numansdorp
Lage Zwaluwe
Hooge Zwaluwe
Moerdijk
Zevenbergsche Hoek
Hollandsch Diep
Den Bommel
Nieuwe Tonge
Oude-Tonge
Ooltgensplaat
Hellegatsplein
WILLEMSTAD
Zevenbergen
Wagenberg
Den Hout
Oosterhout
Gravenmoer
Klundert
Langeweg
Rijen
Krammer

PROGRAM HBM 4000 DEMONSTRATION

Thursday, February 22, 1979.

09.15 hrs	Guests assemble in front of Rotterdam Hilton Hotel. Boarding buses.
09.30 hrs	Buses leaving.
10.00 hrs	Arrival at Motel "Papendrecht" - Restaurant "De Staatse Schans"
10.00 - 12.00 hrs	Coffee. Briefings by Dr. J.W. Jansz, managing director Hollandsche Beton Groep, Research and Development.
12.00 hrs	Departure for Test Site.
12.30 - 13.30 hrs	Demonstration of HBM 4000 piledriving system.
13.30 hrs	Departure for Motel"Papendrecht" - Restaurant "De Staatse Schans"
14.00 - 16.00 hrs	Cocktails. Cold Buffet.
16.00 hrs	Departure for Rotterdam Hilton. Informal discussion.

PROGRAM

Demonstration
of
Hydroblok HBM 4000
Piledriving Hammer

Thursday, February 22, 1979

09.15 hrs	Guests assemble in front of Rotterdam Hilton Hotel
	Boarding Buses
09.30 hrs	Buses leaving
10.00 hrs	Arrival at Motel "Papendrecht", Restaurant "De Staatse Schans"
	Participants with own transportation join the group
10.00 - 12.00 hrs	Coffee
	Introduction by Messrs Verolme Engineering Company
	Briefings by Dr. J.W. Jansz, Managing Director HBG, Research and Development and by Messrs Netherlands Offshore Company
	Questions
12.00 hrs	Departure for Test Site
12.30 - 13.30 hrs	Demonstration of HBM 4000 Piledriving System
13.30 hrs	Departure for Motel "Papendrecht", Restaurant "De Staatse Schans"
14.00 - 16.00 hrs	Cocktails
	Cold Buffet
16.00 hrs	Departure for Rotterdam Hilton
	Informal discussions

HYDROBLOK HAMMER EXPERIENCE RECORD

Februari 1979

Client	Year	Project Location	above/under water	Water-depth	Hammer	Piles	Penetration	Soil	Contractor
Péchiney	1970	Flushing NL.	above	-	H.B.M.14	concrete	34 m	clay,sand	HBM
Publ.W.Rdm	1971/72	Europort NL	above	-	H.B.M.850	concrete 59.45 cm	34 m	sand	HBM
Min.Publ.W.	1973	Zealand,NL	above	-	H.B.M.850	200 steel piles,dia 106cm	12 m	clay, sand	HBM
Publ.W.Adm	1974	Amsterdam NL	above	-	H.B.M.500	2000 concrete piles	18-24 m	peat,sand	HBM
Shell Oil Comp.	1974	Gulf of Mexico Marsh Island Block 130	under	217 ft (66m)	H.B.M.500	1 steel pile 24"dia,1"w.t.	350 ft. (160m)	stiff clay, silts	McDermott HBM
Min.Publ. Works	1974/75	Eastern Schelde River NL	under	10m.	H.B.M.500	Various tests a.o.underwater compaction	--	--	HBM
Publ.W.Adm	1974/75	Amsterdam,NL	above	--	H.B.M.500	950 steel piles box type	25-36 m	peat,sand	HBM
Greater London Council	1974/76	Thames Barrier U.K.	above	--	H.B.M.850	Steel profiles Larsen 6 and PSP 8005	15-20 m	peat,sand clay,chalk	HBM
Publ.W.Rdm	1976	Rotterdam,NL	above	--	H.B.M.500	Steel sheet piles	--	peat,clay sand	HBM
Occidental of Scotland Inc.	1976	Claymore field, North Sea	above	360 ft.	H.B.M.3000	4 steel piles dia 48" 24 steel piles dia 60" batter 10.7:1	150 ft.	clay,sand-layers	Neth.Offsh Comp.NOC.
Kellog's	1977	Cork,Dublin Ireland	above	12m	H.B.M.850	400 steel piles 24"	15-18 m	sand, weathered rock	HBM

Placid Intl. Oil Ltd.	1977	Platform L10/D North Sea Dutch Sector	above	90 ft	HBM 3000	4 steel piles dia 42",1,5" wt batter 7.1:1	177 ft. (53 m)	sand	Neth.Off-shore Co NOC.
Pennzoil Ned. Comp.	1977	Platform K13/c North Sea, Dutch Sector	above	90 ft	HBM 3000	4 steel piles dia 42",batter 5.6:1	190 ft (58m)	sand	Neth.Off-shore Co NOC.
Placid Intl. Oil Ltd.	1977	Platform L10/E North Sea Dutch Sector	above	90 ft	HBM 3000	4 steel piles dia 42", 1S/1.75" wt batter 7.1:1	176 ft (50 m)	sand	Neth.Off shore Co NOC.
Shell Oil Comp.	1977	Cognac Field, Gulf of Mexico	under	1050 ft (300m)	HBM 3000A	24 steel piles, dia 84",2" w.t., L.625ft(190m)	490 ft (150m)	soft clay	McDermot Hydrobl Unit.
Single Buoy Moorings Inc (SBM)	1977	Pulay Field South Chinese Sea	under	60 m	HBM 500	6 steel piles dia 24/48",w.t. 1.5/1.25" L:98ft(30m)	76 ft (23.2m)	very stiff to firm clay	Hydrobl Unit
Min.Publ. Works	1977/79	Gouda Tunnel NL.	under	2-16 m	HBM 500	2800 concrete piles sq.40 cm	14-15 m	sand	HBM
Min.Publ. Works	1978	Gouda Tunnel,NL	above	--	HBM 500	400 concrete piles sq.40cm	17 m	peat, sand	HBM
Occidental Oil	1978	Piper field, North Sea, British sector	under	150 m	HBM 1500	8 steel anchor-piles dia,60" L=94ft.	100 ft (30m)	soft to stiff clay	Hydrobl Unit
Petroland BV	1978	Platform L7BB North Sea Dutch sector	above		HBM 3000	4 steel piles, dia 42", w.t. 2/2,5"	191 ft (58m)	sand	Neth.Of shore C (NOC)
Electr.Comp. Denmark	1978	Asnaes,DK	above	18-20m	HBM 500	24 steel piles dia 24"	12-15 m	clay,sand	HBM
PhilippHolzmann Germany	1978	Hamburg Harbour Germany	under	6 m	HBM 500	120 steel H-piles		sand/gravel	HBM

23.	Electr.Comp, Denmark	1979*	Asnaes,DK	above	18-20m	HBM 500	340 piles,dia 24"	12-15 m	clay,sand	HBM
24.	Min.Publ. Works	1979*	Eastern Schelde river NL.	above	15-30m	HBM 1500	47 piles,dia 48"	30 m	sand	HBM

* to be executed

EXPERIENCE

WITH

HBM HYDROBLOK HAMMERS

HBM-4000/February 1979

NOC

NOC EXPERIENCE RECORD HYDROBLOKS HBM 3000

TABLE I

Client	Project	Period	Number of piles and sizes	Wall Thickness	Penetration	Soil Condition	Pile Batter	Actual Driving Time
NOC	Testdriving on-shore in Holland	1974	1x84 in diam.	-	-	-	Nil	±20 hr
AMOCO UK	Montrose platform North Sea U.K. Sector	July 1975	28x48 in diam.	2.0 in	hammer on standby only			
Occidental of Scotland Inc.	Claymore platform North Sea U.K. Sector	July 1976	2x48 in.diam. 19x60 in diam.	2.0 in	46 meter (150 feet)	Alternate Clay and Sand Layers	10.7:1	14.6 hr
Placid International Oil Ltd.	Platform L10/D North Sea Dutch Sector	May 1977	4x42 in diam.	1.5 in	53 meter (175 feet)	Sand	10.0:1 7.1:1	6.2 hr
Pennzoil Nederland Company	Platform K13/C North Sea, Dutch Sector	July 1977	4x42 in diam.	1.25/ 2.125 in	58 meter (190 feet)	Sand	8.0:1 5.6:1	4.4 hr
Placid International Oil Ltd.	Platform L10/E Norht Sea, Dutch Sector	Sept.1977	4x42 in diam.	1.5/1.75 in	54 meter (176 feet)	Sand	10.0:1 7.1:1	5.7 hr
Petroland B.V.	Platform L7BB North Sea, Dutch Sector	Sept.1978	4x42 in diam.	2.0/2.5 in	58 meter (191 feet)	Sand	5.6:1	2.8 hr

TOTAL: ± 154 hr

OCCIDENTAL CLAYMORE

particulars

Piledrivers at jobsite:	2 x HBM 3000 and 3 x Menck MRBS 8000		
Installation vessels/barges:	Challenger one side Herculess (shortly Orca) other side		
Piles driven to final penetration by different hammer types:	2 x HBM 3000 :	2 x 48 inch piles 19 x 60 inch piles	total of 21 piles
	3 x Menck MRBS 8000 :	2 x 48 inch piles 5 x 60 inch piles	total of 7 piles
Hammer problems:	2 x HBM 3000	- lubrication of guiderails - steering hoses - piston rods connection collapsed	
	3 x Menck MRBS 8000	- anvils cracked - cilinder lining problems	

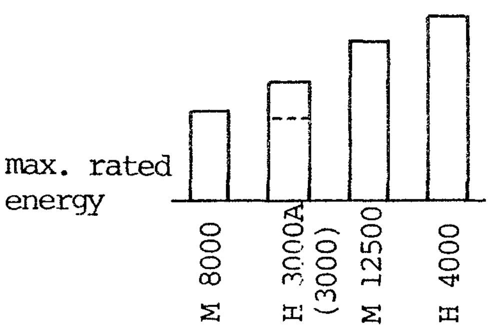
At end of pile driving 4 out of 5 hammers were unuseable, one HBM 3000 finished the driving job !

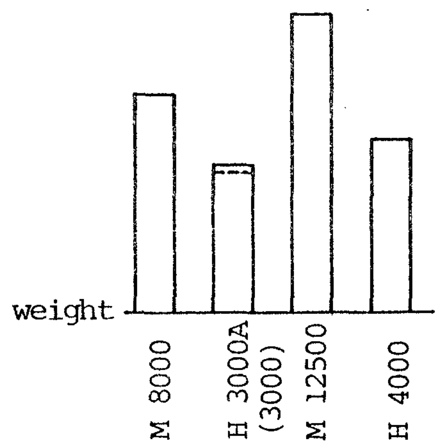
COMPARISON ⊠

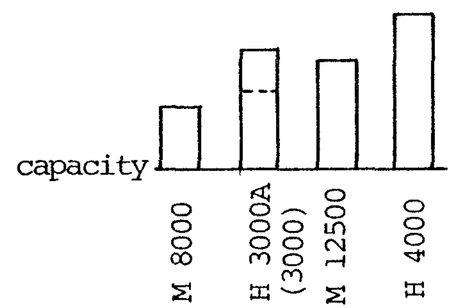
HEAVY PILE DRIVERS

TABLE II	MRBS 8000	HBM 3000A (3000)	MRBS 12500	HBM 4000
Max. rated energy	867.960 ft/lbs 120.000 mkg	1.100.000 (774.000)ft/lbs 157.000 (107.000)mkg	1.582.220 ft/lbs 218.750 mkg	1.700.000 ft/lbs 232.000 mkg
Net driving energy	781.165 ft/lbs 108.000 mkg	795.600 (542.000)ft/lbs 110.000 (75.000)mkg	1.424.000 ft/lbs 196.875 mkg	1.157.000 ft/lbs 160.000 mkg
Weight	277 ton	188 (175) ton	385 ton	226 ton
Blows per minute	38 bl/min	70 bl/min	36 bl/min	70 bl/min
Driving capacity (en/t.unit)	4.104.000 mkg/min	7.700.000 (5.250.000)mkg/min	7.087.500 mkg/min	11.200.000 mkg/min

⊠ information drawn from manufacturer's sales brochures







HBM-4000 TYPE HYDROBLOK HAMMER UNDER DURATION TEST, SLIEDRECHT 1979.

Today, February 22, 1979 you will see a more than life-size test site. The most powerful hammer in the world, driving an 84 inch pile to a penetration of more than 230 ft.

WHY ALL THIS EFFORT?

We have three goals in mind, viz.:

1) It must be proved to the client, in this case The Netherlands Offshore Company, that their hammers can meet the guaranteed performance specifications over an extended period of time.
2) The Hydroblok organization wants to check its design calculations and to calibrate its design techniques for future developments.
3) This opportunity is utilized to gather information of a more general nature about the interactive behaviour of the total hammer-pile-soil system.

1) Performance

The test has clearly shown that this huge hammer really will do the job it was designed for. But what do we really mean by performance? The hammer must generate energy, necessary to achieve penetration, to achieve plastic deformation of the soil. The pile transports the energy from the hammer to the soil.
The only meaningful yardstick to measure the energy is the kinetic energy of the ram immediately before it hits the anvil:

$$E = \frac{1}{2} Mv^2.$$

The mass M is known from calculations, and more accurate also from the fabricators weighing procedure sheet.
The impact velocity v is measured and visualized at the operators console. In our case the velocity is determined by the timedelay t between two adjacent points that are passed by the ram. (Incidentaly also the rebound velocity is indicated by the same means). The velocity indicator is carefully checked and calibrated and it is a standard built-in piece of equipment in every Hydroblok hammer.

Does the pile accept all that energy from the hammer?
It depends on the relative properties of the combination of pile and hammer. At a certain impact velocity v a given pile can only absorb a certain force per time-span and the excess force is bounced back into the hammer, and is therefore lost to the driving process. Here the adjustable Hydroblok buffer-force comes into the picture.
The operator can regulate the impact force during driving independently from the energy. Conventional hammers allow such a force-adjustment only by adapting (i.e. reducing) the energy. This unique feature allows the energy to be temporarily stored in order to stretch the blow over a

longer period of time by merely adjusting the bufferforce, constantly working with the same optimum energy level of each hammerblow. This in fact is the key to fast driving, as has been proved in many offshore operations where short driving times have amazed so many.

During testing various bufferforces and impact velocities were used. The impact-force diagrams have also been measured to check the diagrams calculated with the PILEWAVE-computerprogram.

The HBM-4000 delivers more than its guaranteed kinetic energy of 120 000 lb.ft. (160 tfm) at buffer forces varying from 2500 tonforce to 4000 tonforce.

2 Design Check.

The built-in buffer protects the hammer from excessive stress and strain. At moment of impact shock-waves start to travel not only in the pile, but also in the hammer. Now peakforces are controlled by the buffer and consequently kept within acceptable limits. This makes it possible to design the various hammer parts properly on fatigue. Extensive stress and strain calculations have been performed, both statically (figure 1) and dynamically (figure 2 and 3), the latter being based on known impact speeds of the various colliding hammer-parts. Test measurements during actual piledriving have proved that these complex calculations correctly assess what happens in practice. Therefore we can be sure that the hammer is designed as a reliable tool, suitable to be used underwater during longer periods.

3 Hammer-pile-soil behaviour.

Extensive tests and measurements have been performed to determine stresses and accelerations at the top and near the toe of the pile. Soil investigation has been carried out before driving. During driving pore pressures and total soil pressures were recorded .
This part of the test gathers information of a more general interest. It has been made possible through the generous support and participation of a broad international forum:

- Amoco U.K. Exploration Company
- Britisch Petroleum Trading Ltd.
- Det Norske Veritas
- Delft Soil Mechanics Laboratory
- Groupe Elf-Aquitaine
- Hollandsche Beton Groep
- Industriele Raad voor de Oceanologie
- Institut Français du Pétrole
- Lloyd's Register of Shipping
- Marathon Oil Company
- Netherlands Offshore Company

and pore pressure and total pressure measurements were made by

Building Research Establishment.

Much valuable information has been gathered and the final report will be issued to the sponsors before 1 March 1979.

Now that the "WHY?" has been clarified it is time to tell something about "WHAT" you will see at the testsite. We refer to figure 4. At the site there already was available an 84 inch vertical pile (1) in fig. 4), which was used to test previous hammers. This time the test procedure called for a batter pile 7 on 1. (2) in fig. 4). During driving the inclination increased to 5 on 1 due to deformations in the soil. The inclined testpile is closed at its toe and the outer diameter is 84 inch, wallthickness 1.25 inch. During driving the pile was supported in the beginning by the means of brackets A and B connected to the vertical pile. Brackets A) and B) are removable and they were taken away and replaced again as the driving procedure progressed and successive add-ons were welded. The total length now is 71 m (235ft.) The 7 m deep hole (3) in fig. 4) is protected by steelpiling. It can be emptied by pumping out water and it has been utilized for welding operations and it allows the hammer to drive the pile a further 5 m below groundlevel should that be necessary.
The first 9 m of Soil consist of peat, then up to 40 m layers of clay with medium dense sands. From 40 m to 70 m we find dense sands and below 70 m clay with dispersed sand layers.
A blowcount graph is added to this information-package as fig. 5.

Finally a number of maximum values are given that have been reached at any time during the testing program of some 33 hours of driving, though not all in combination. (catalog values between brackets)

Net impact energy of ram ($\frac{1}{2}mV^2$)	ton.meter	190	(160)
	ft.lbs	1370.000	(1200 000)
Bufferforce maximum	tonf	4000	(4000)
	kips	8800	(8800)
Maximum blowcount	per 25 cm	40.000	
	per foot	49.000	
Hours effective driving on testpile (15 Febr.79)	hammer 4001	23 hrs. 17 min.	
	hammer 4002	11 hrs. 7 min.	

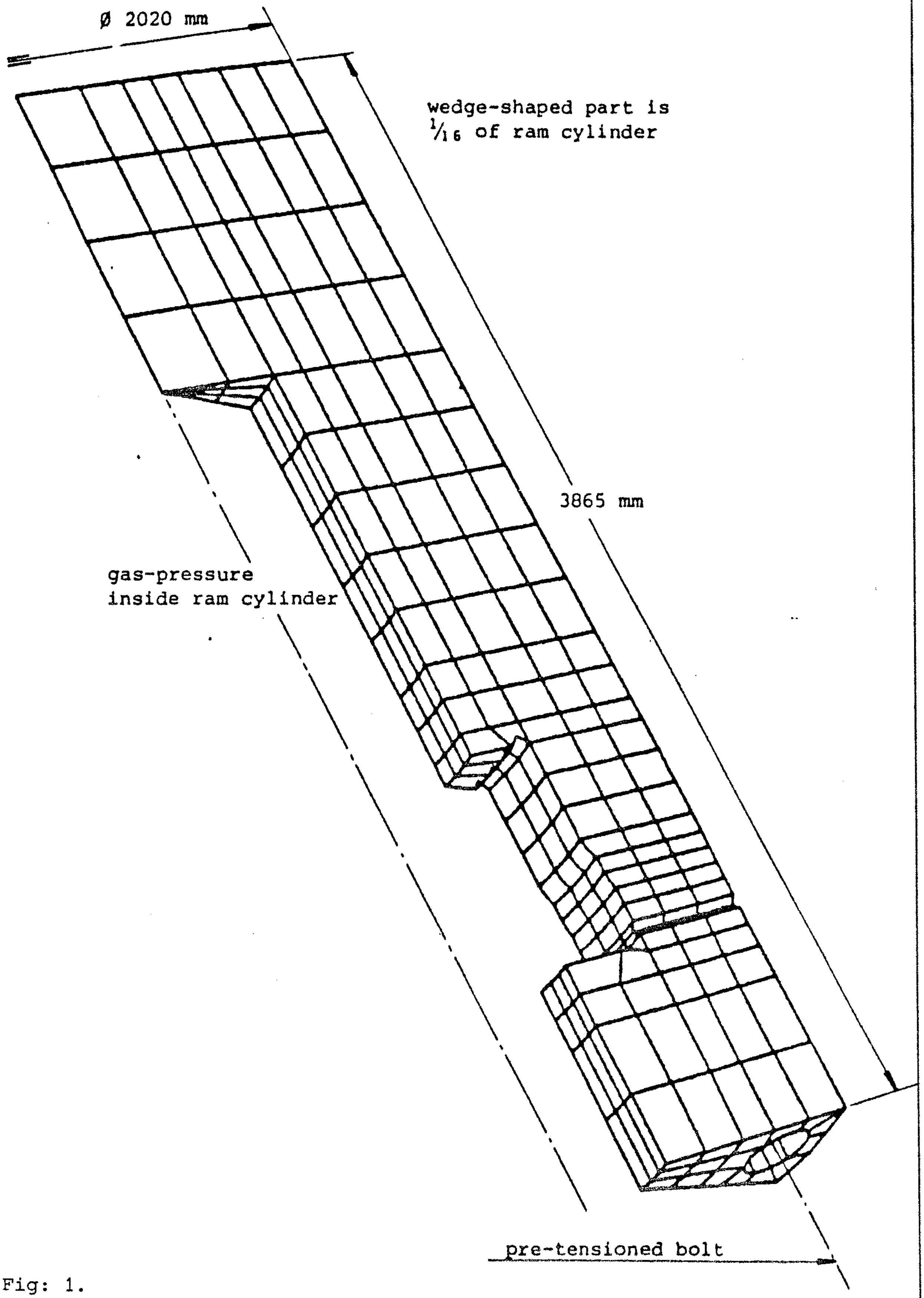


Fig: 1.

Three-dimensional finit element model representing the ram of Hydroblok hammer HBM 4000. Calculations provide stress and strain in each part of the ram under various static conditions.

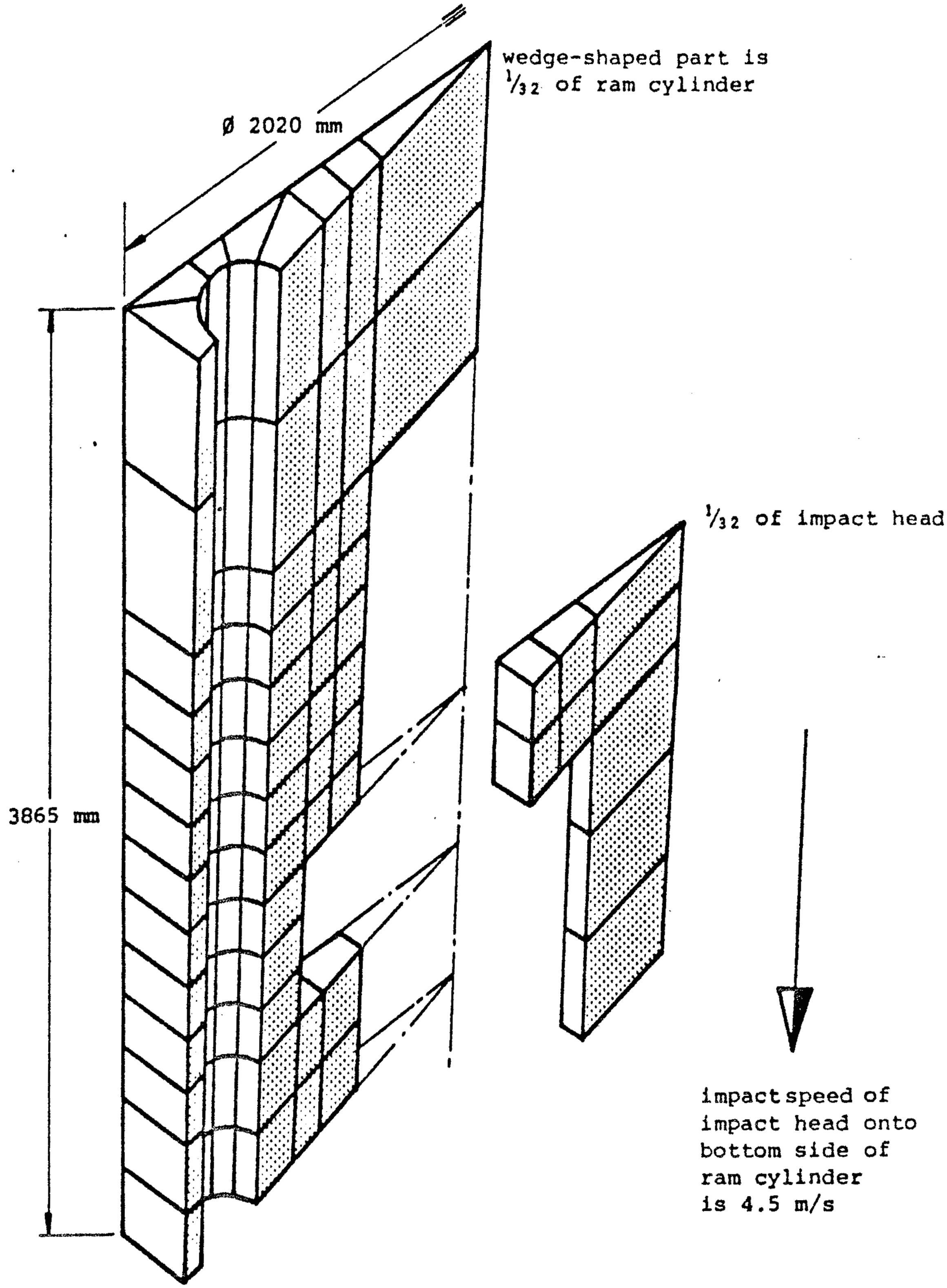


Figure 2 : Three-dimensional finit element model representing the ram of a Hydroblok hammer HBM 4000.
The model includes next to stress-strain relations also mass; it is suited to perform dynamic calculations.

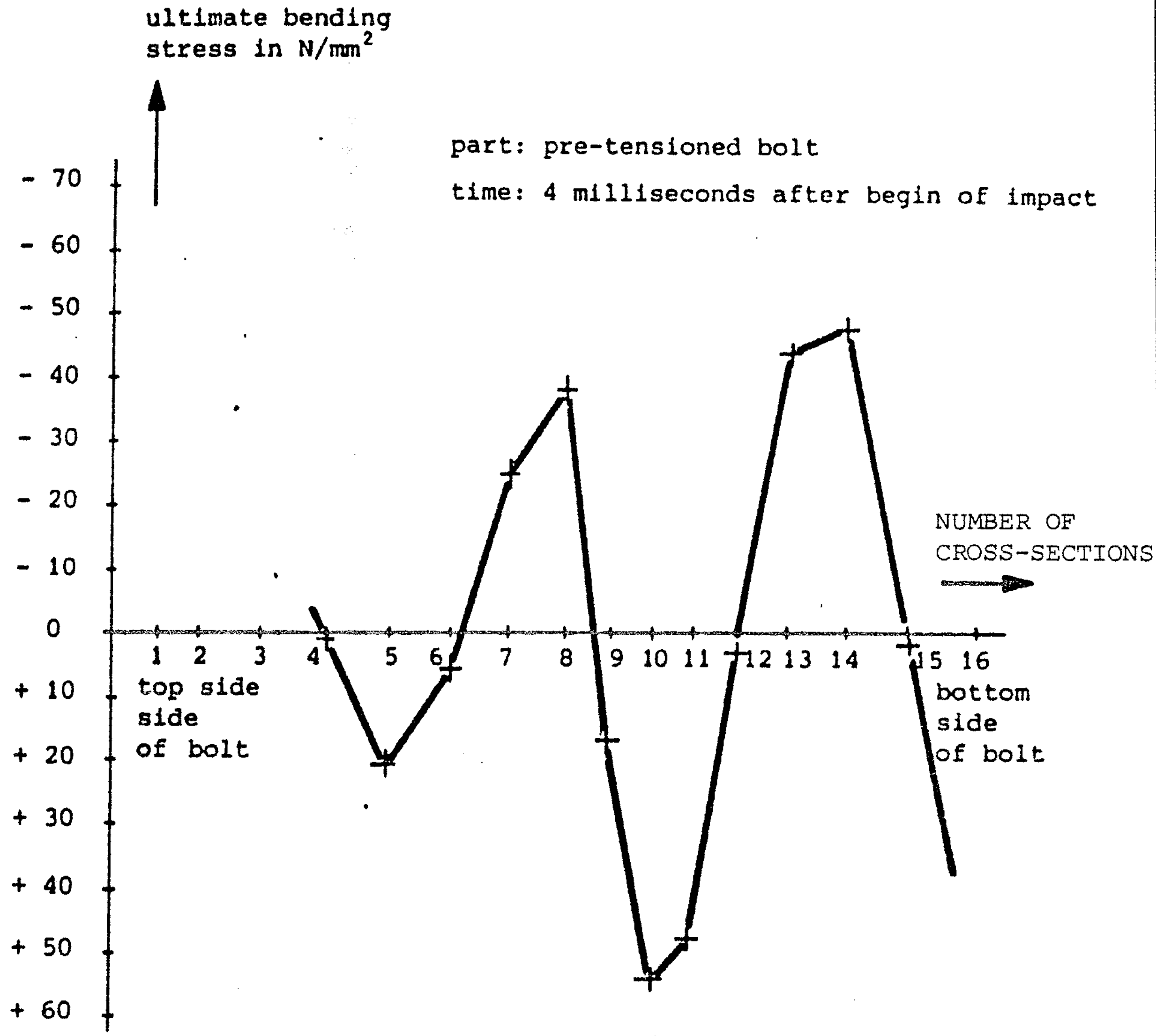


Figure 3: Typical result of dynamic calculation with the model shown in figure 5. All heavily loaded parts of a Hydroblok hammer are calculated in a similar way.

SLIEDRECHT PILETEST 1978-1979

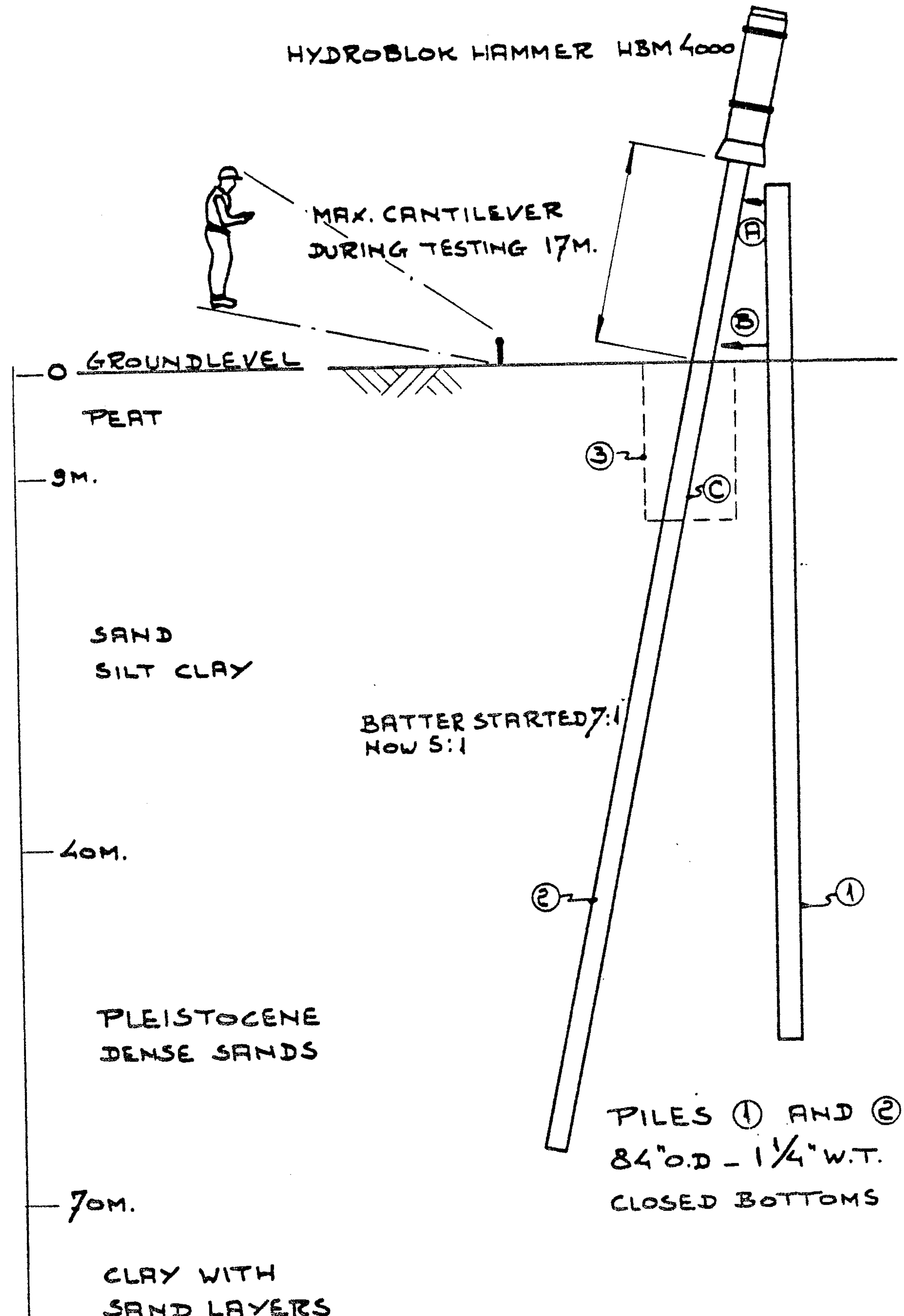
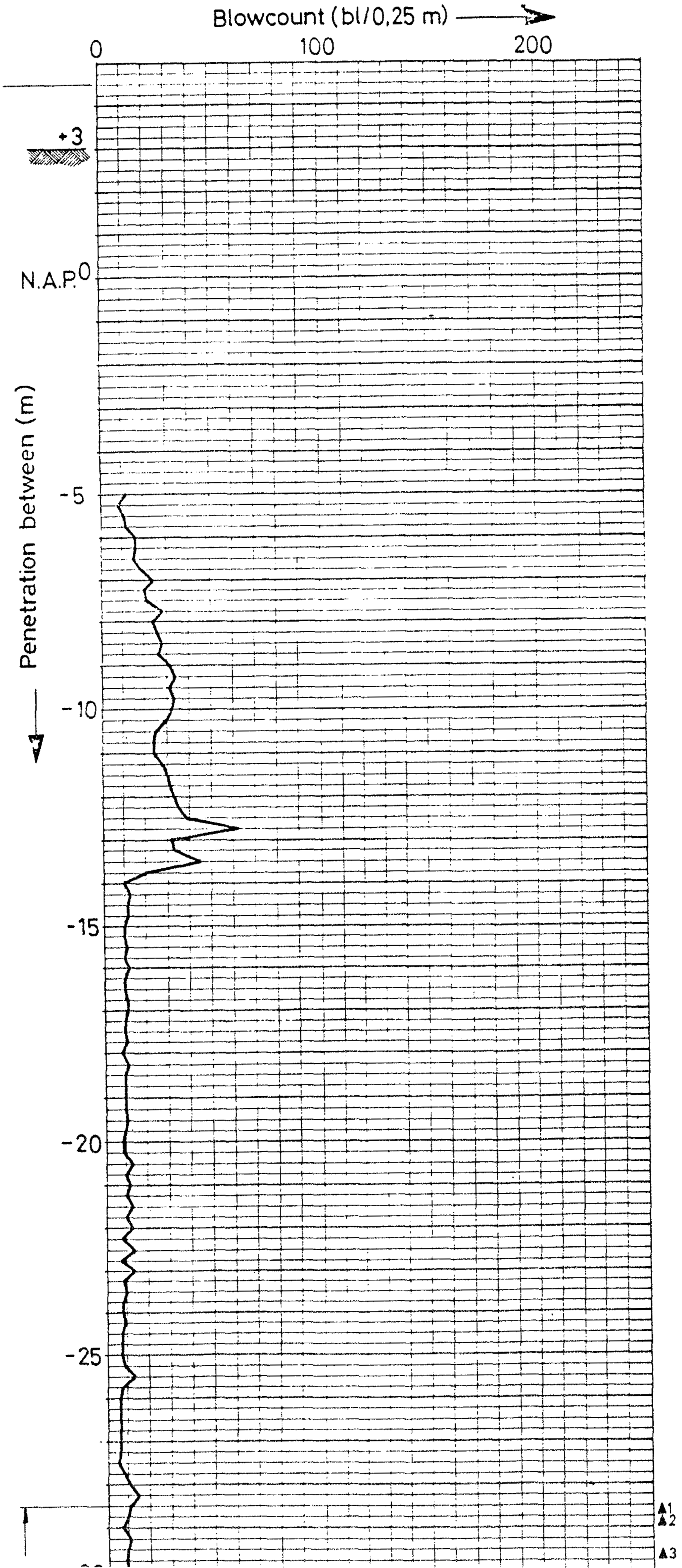
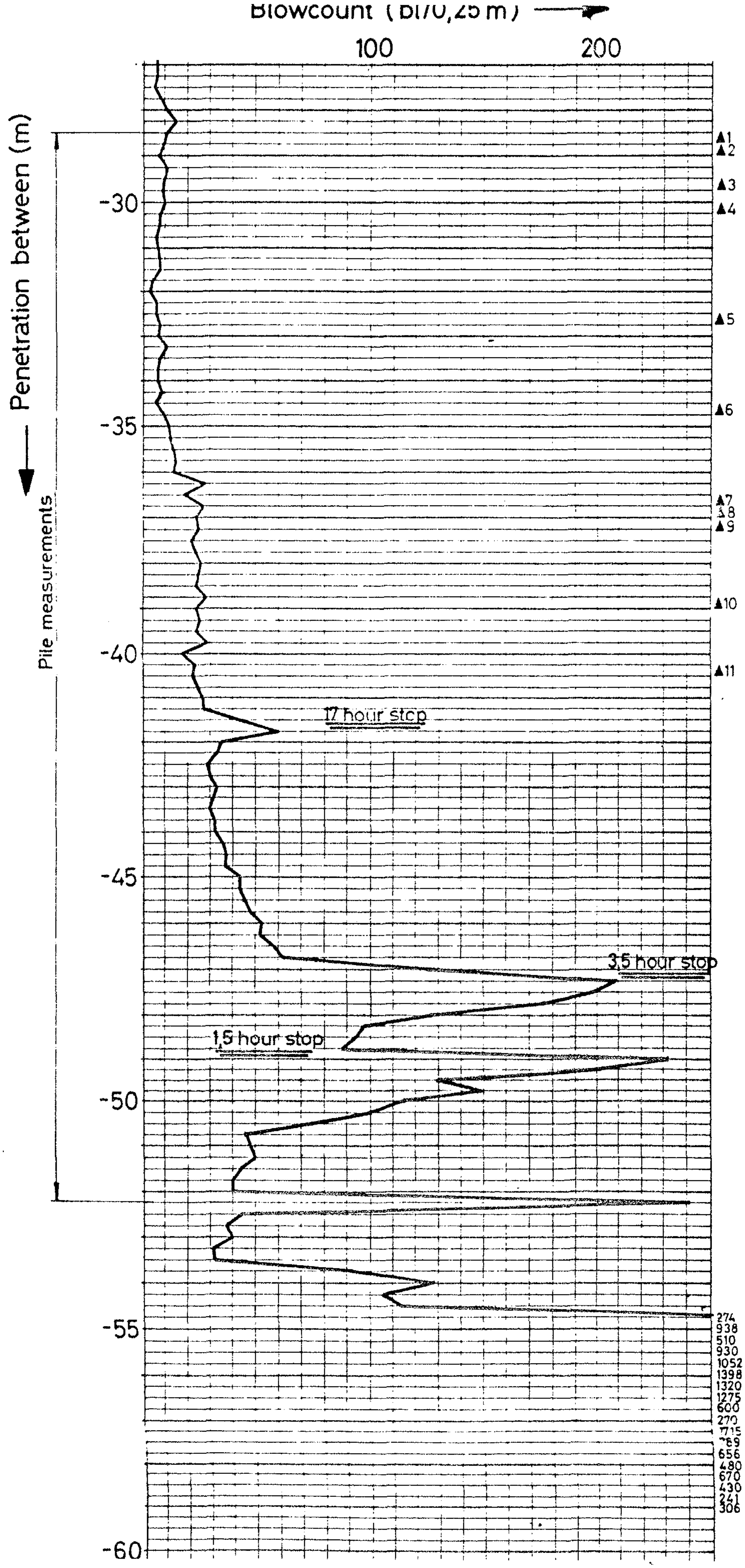


FIG. 4



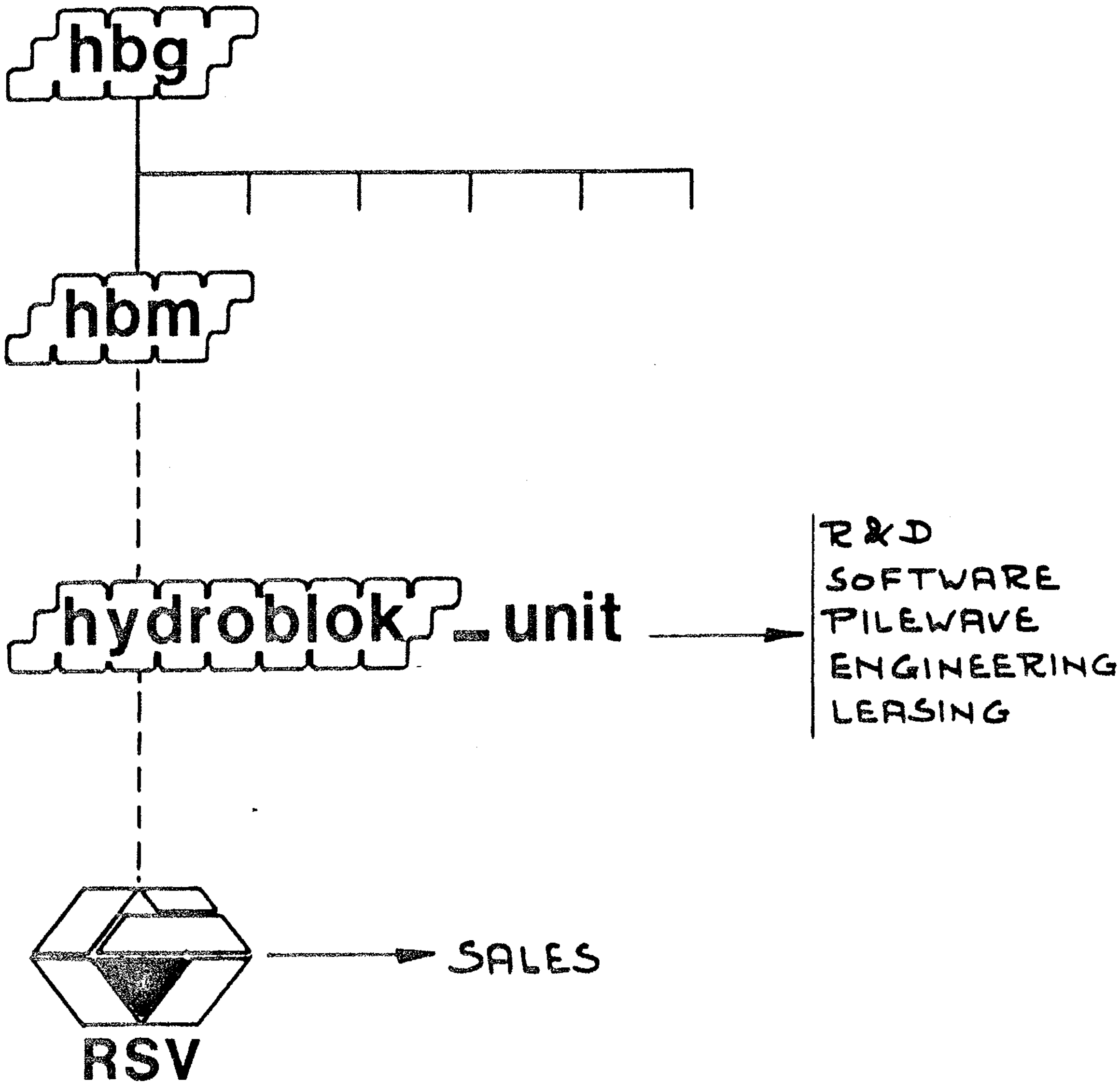
Sliedrecht, pile test 30,31-Oct.-1978

Fig. 5.



Sliedrecht, pile test 30,31-Oct.-1978

Fig. 5.



hydroblok **hollandsche beton maatschappij bv** 9.04.71

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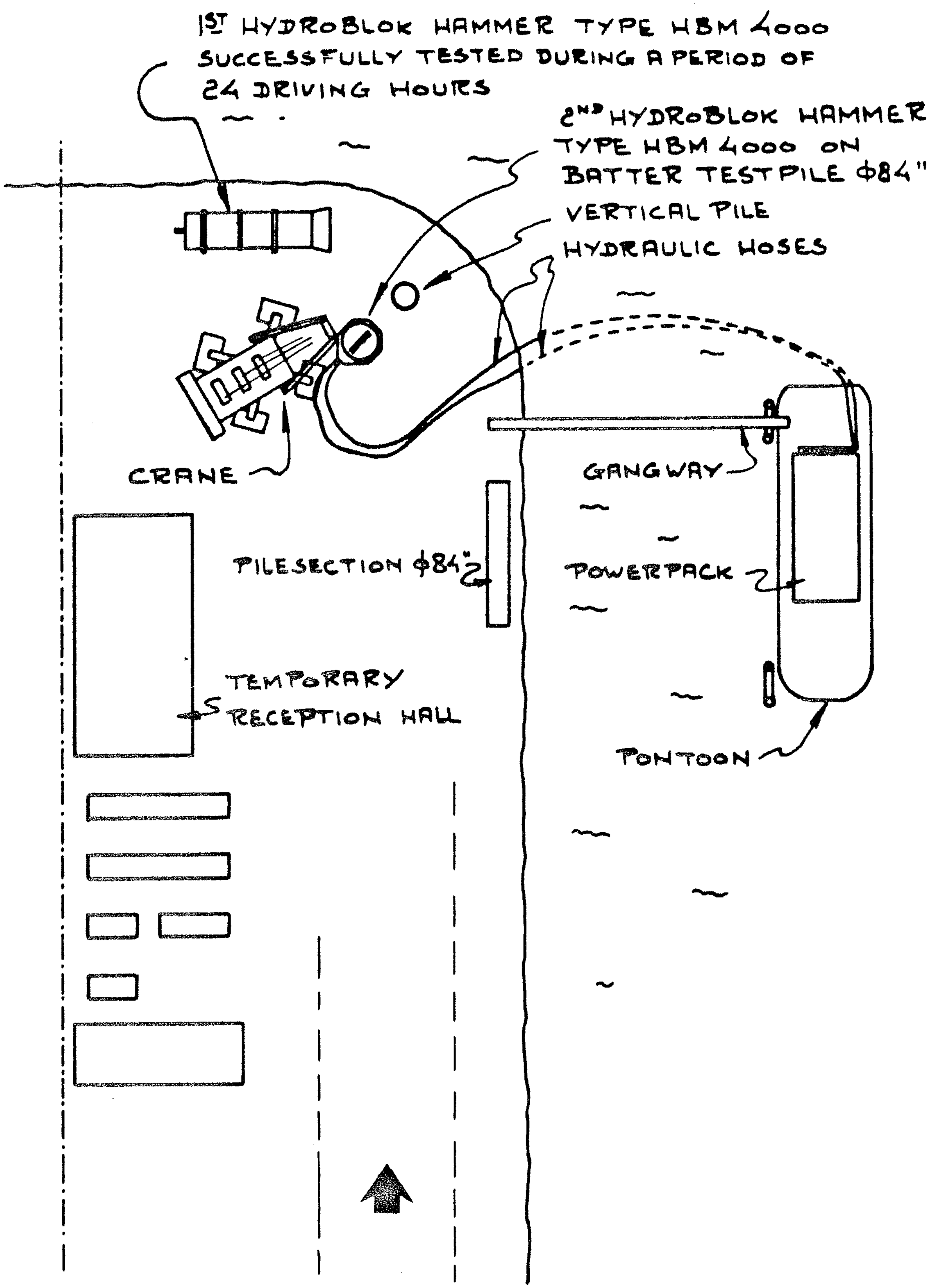
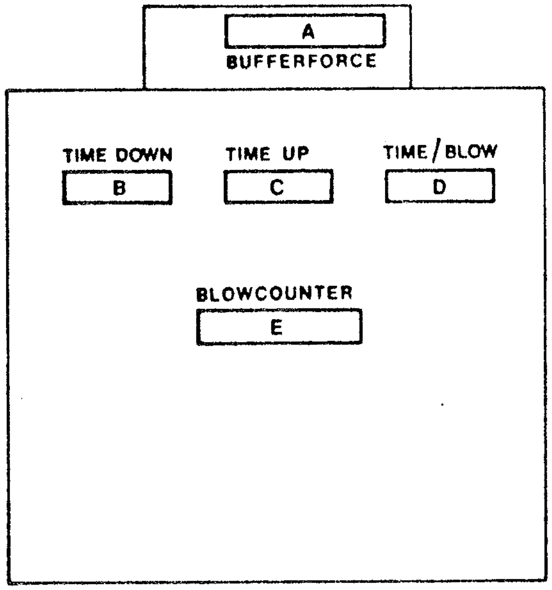
SITUATION ON TEST-SITE



(NL) SLIEDRECHT PILEDRIVING TESTSITE
FEBR. 1979



Display B	Net Impact Energy of ram HBM 4000		
ms	kNm	ton m	ft.lbs
8.4	2007	205	1 479 000
8.5	1946	198	1 434 000
8.6	1885	192	1 389 000
8.8	1826	186	1 346 000
8.9	1767	180	1 303 000
9.0	1710	174	1 260 000
9.2	1653	169	1 219 000
9.4	1598	163	1 178 000
9.6	1543	157	1 137 000
9.7	1490	152	1 098 000
9.9	1437	146	1 059 000
10.1	1385	141	1 021 000
10.3	1334	136	983 000
10.4	1284	131	947 000
10.6	1235	126	911 000
10.8	1188	121	875 000
11.0	1140	116	841 000
11.2	1094	112	807 000
11.5	1049	107	773 000
11.8	1005	102	741 000
12.0	962	98	709 000
12.3	920	94	678 000
12.5	878	90	647 000
12.8	838	85	618 000
13.1	798	81	588 000
13.4	760	77	560 000
13.8	722	74	532 000
14.1	686	70	506 000

A = BUFFERFORCE IN METRIC TONS

B = TIMESPAN ↓ } OVER SAME DISTANCE

C = TIMESPAN ↑ }

BLOWS PER MINUTE = $\frac{60}{D}$

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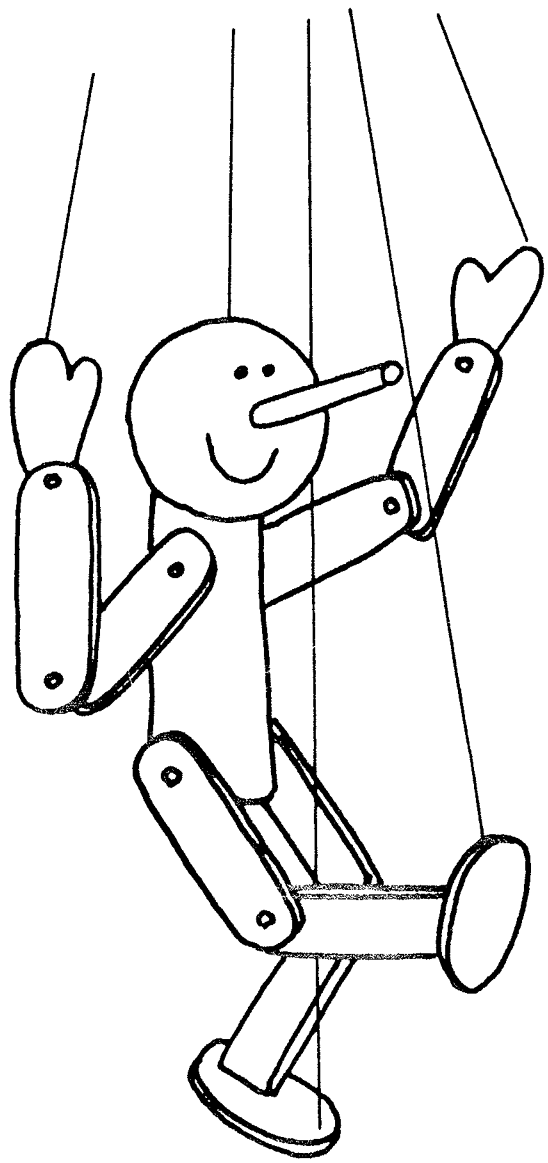
THE PUPPET. SYSTEM

OPERATIONAL IN 1978



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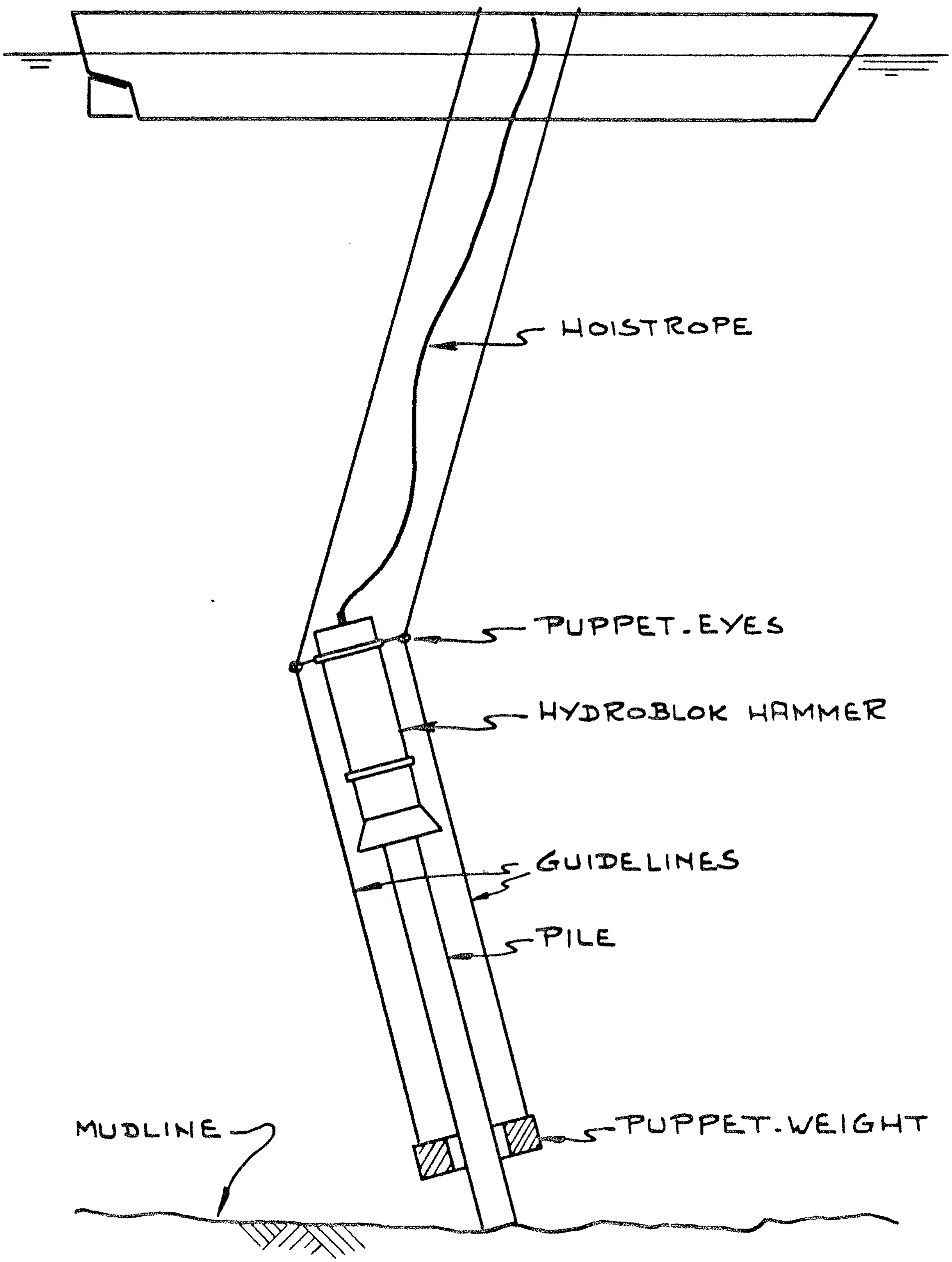
PUPPET. SYSTEM



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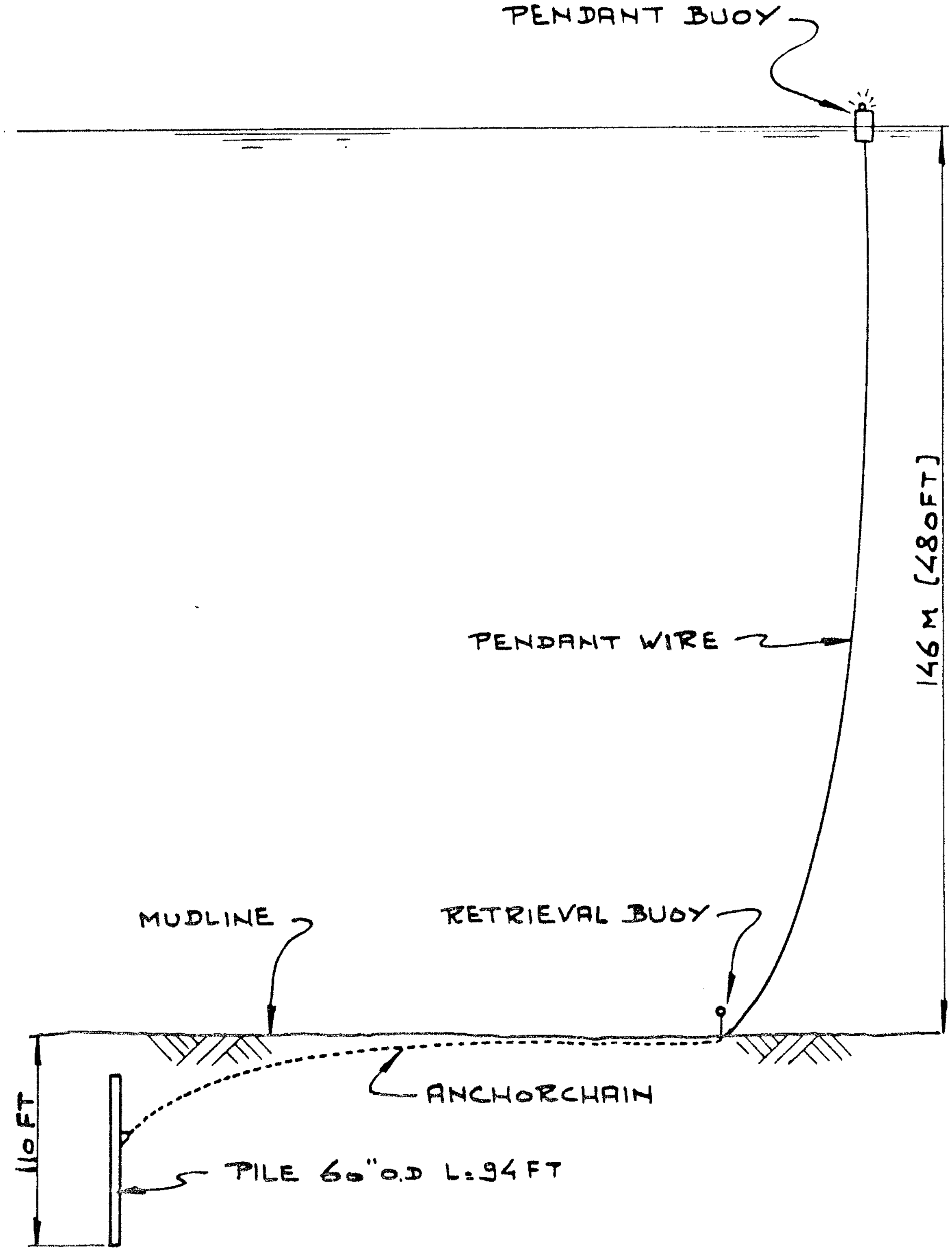
SITUATION PIPER-FIELD
NORTH-SEA 1978



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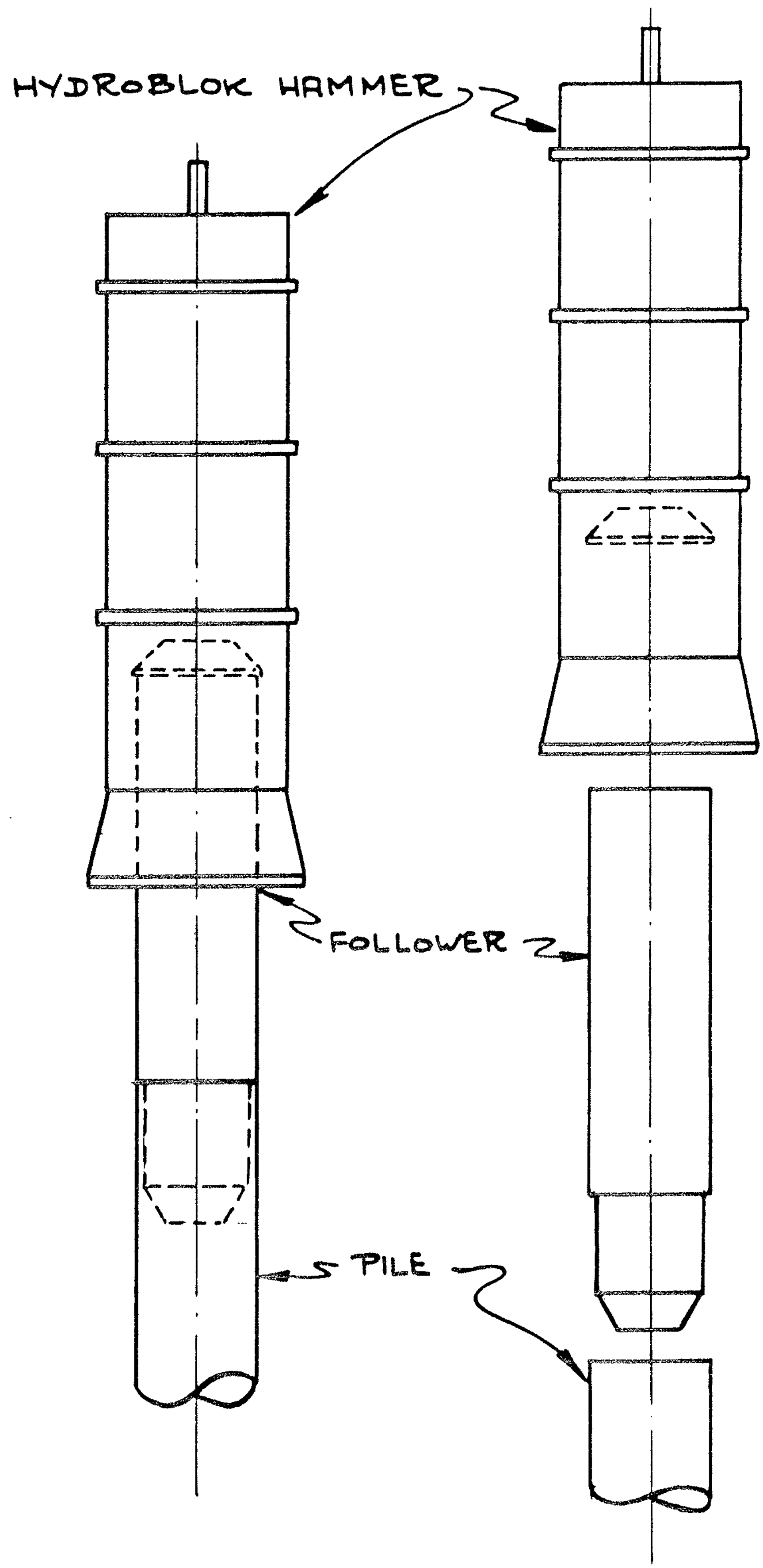

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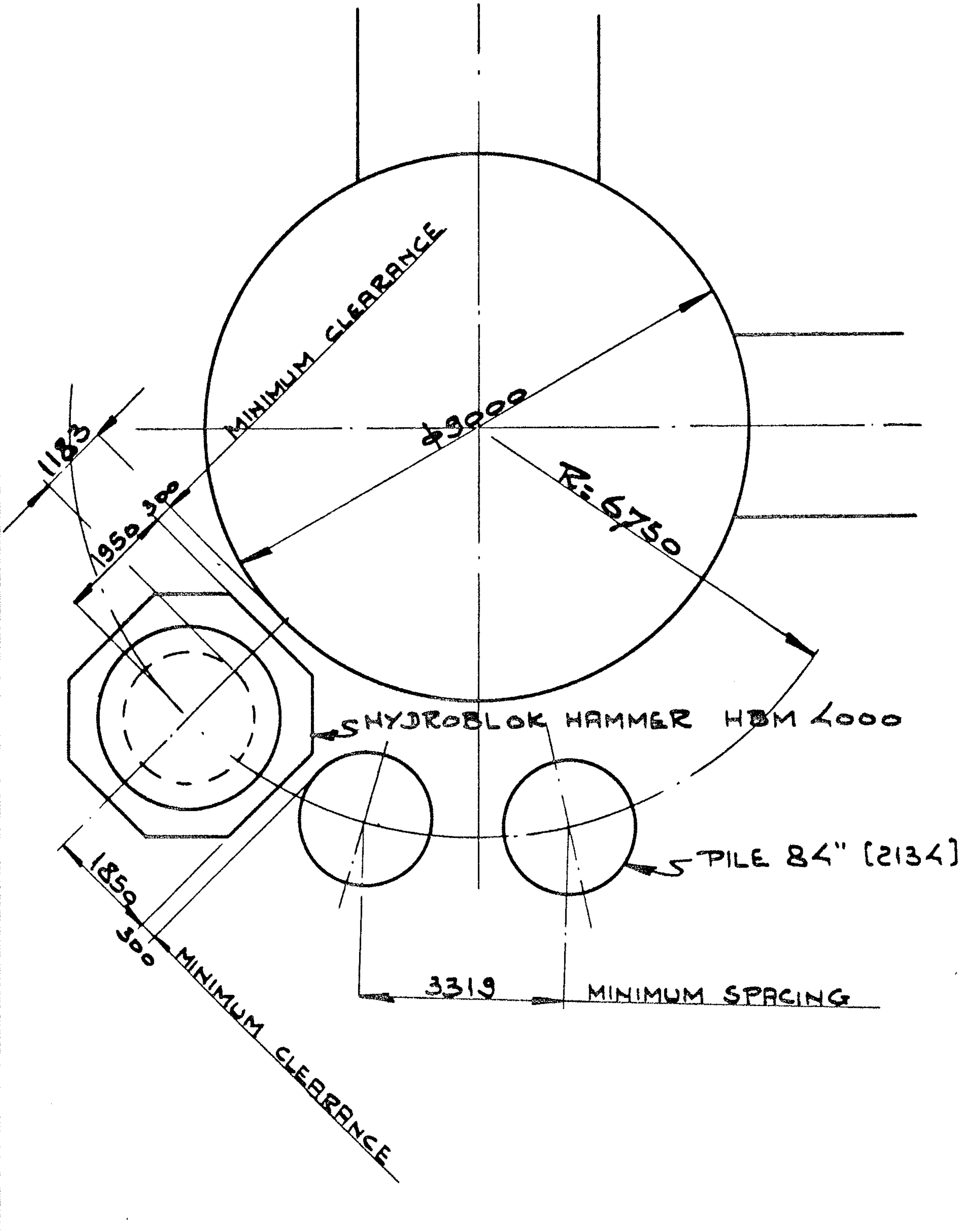
MINIMUM SPACING OF 84" PILES AROUND LEG OF JACKET WHEN USING A HYDROBLOK HAMMER TYPE HBM 4000



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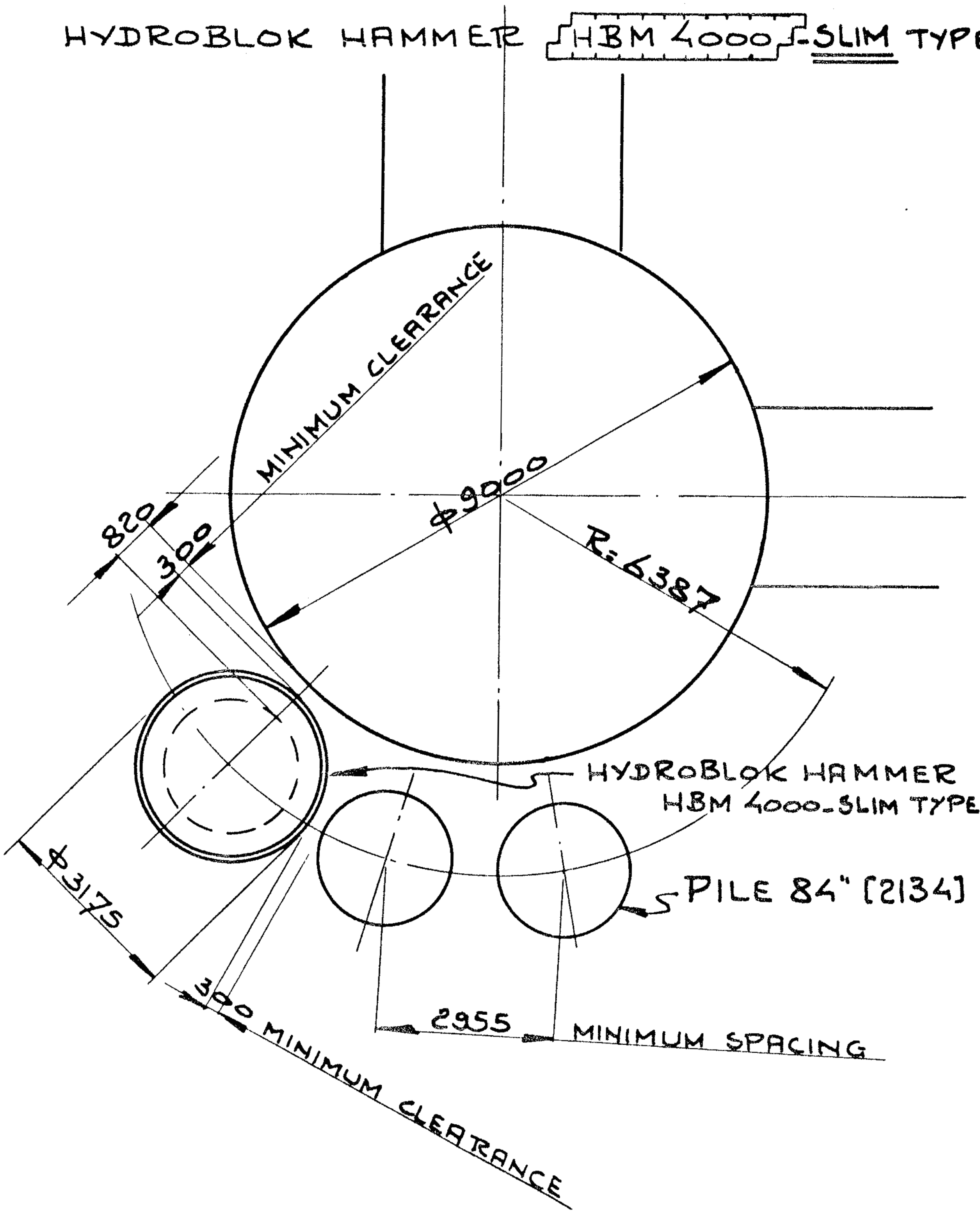
MINIMUM SPACING OF 84" PILES AROUND LEG OF JACKET WHEN USING A HYDROBLOK HAMMER HBM 4000-SLIM TYPE



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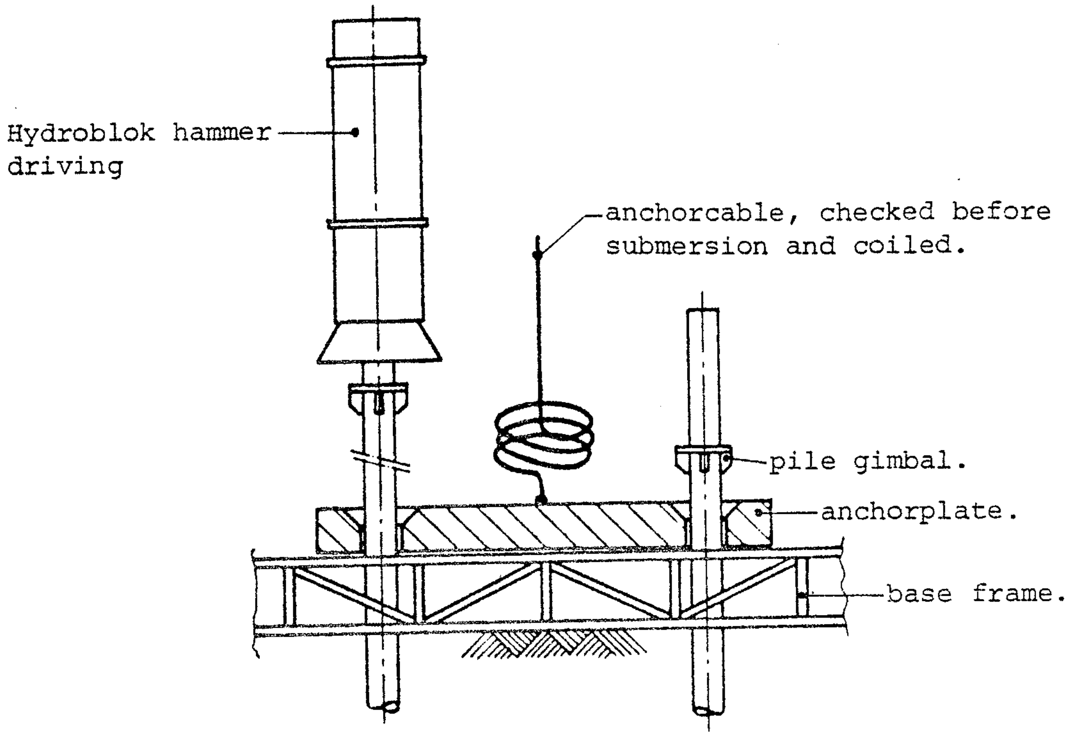
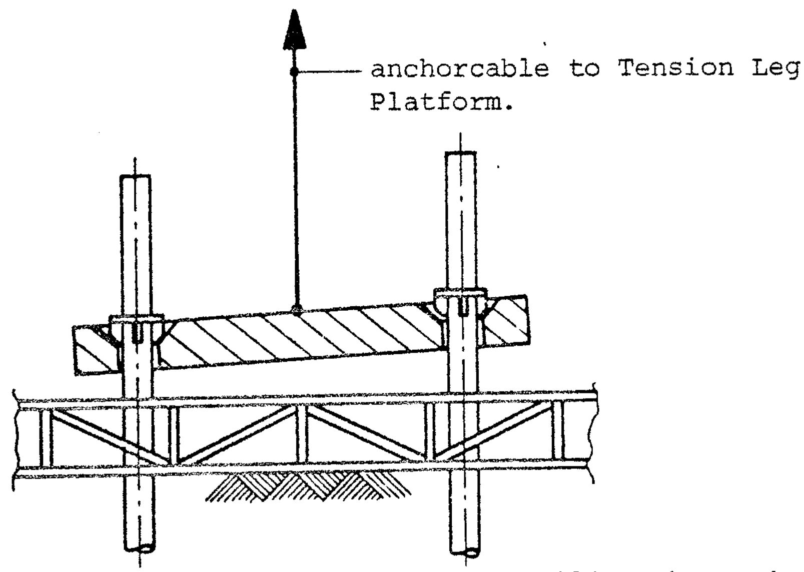
Piled Anchor Point (PAP) System with self-equalizing force distribution for Tension Leg Platforms.





The base frame primarily serves the purpose to stabilize the anchor piles before they are driven. The anchor plate carries the anchorcable(s); the anchorcable-connection can be carefully checked and the cable is coiled before submersion. The anchor piles are driven, and a certain difference in the levels of the gimbals is acceptable. Pulling the anchorcable(s) makes the anchorplate match all gimbals, evenly distributing the anchorforce to all (maximum 3) piles. The baseframe from this moment on has no function anymore, as far as vertical anchorforces are concerned. Pinning the baseframe firmly to the seafloor with separate piles makes horizontal components of the anchorforce not work any more on the vertical anchorpiles. Because of the nature in which TLP-anchorpiles are cyclicly loaded, separation of horizontal and vertical force components can be advantageous.

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THE PUPPET SYSTEMS

The Puppet Systems are Hydroblok's newest methods which make it possible to drive piles insupportedly. In such cases there is nothing to hold the pile upright during the first stage of its installation.

Two variations were developed (figure 1):

Number 1: A method which uses only lateral soil resistance for stabilization.

Number 2: A method where an element is added for self-stabilization, the so-called Puppet Weight.

A standard Hydroblok hammer is the integral part of the Puppet System. During driving a Hydroblok hammer sits freely on top of the pile, while the hoist is kept slack.
The sleeve guides the hammer perfectly onto the pile. This specific feature in combination with the underwater driving capability each Hydroblok hammer basically possesses, provides the elements for the Puppet System.

Puppet System method number 1 that uses lateral soil resistance only was recently described in detail (reference 1). Puppet system method number 2 will be published soon. (references 2 and 3). A short outline will be given here.

The soil-independent Puppet System number 2 (figure 1) requires two puppet-weight-guidelines, running down from the vessel, passing through the puppet-eyes, to the Puppet Weight. The latter is simply a mass, loosely slipped around the pile at a low level, thus producing a tension force in the puppet-weight-guidelines. A component of this tension force acts onto the puppet-eyes, thus stabilizing pile and hammer within certain limits which will be explained hereafter.

A puppet System operation mainly starts with the temporary connection of pile and hammer into one unit. There must be some sort of a hoist (e.g. drillstring) to lower the unit. Figure 2, stage 1, shows the pile shortly before it will touch the sea floor. Because of current-action the pile toe will not remain vertically beneath the vessel, but will deviate a certain distance q_1 (landing distance):

$$q_1 = F_D\left\{\frac{h-l_0}{G_1+G_2+G_3} + \frac{l_0(l_0-l_D)}{G_1(l_0-l_1)+G_2(l_0-l_2)+G_3(l_0-l_3)}\right\} \quad (1)$$

F_D represents the resultant of all current forces on the system acting at a distance l_D above the pile toe. Further symbols will be clear from figures 1, 2 and 3. The corresponding pile angle α_1 (landing angle):

$$\alpha_1 = \frac{F_D(l_0-l_D)}{G_1(l_0-l_1) + G_2(l_0-l_2) + G_3(l_0-l_3)} \qquad (2)$$

To make the calculations in a conservative manner, a possible position change Δq of the vessel will be assumed to occur in the time-split between touch-down and the beginning of the pile's self-penetration (stage 3). This results in a horizontal distance q_s (stabbing distance) between pile toe and vessel, with corresponding pile angle α (stabbing angle):

$$q_s = q_1 + \Delta q \qquad (3)$$

$$\alpha_s = \frac{q_s.l_0(G_1+G_2+G_3) + F_D.l_D(h-l_0)}{h.l_0(G_1+G_2+G_3) - (G_1l_1 + G_2l_2 + G_3l_3)(h-l_0)} \qquad (4)$$

The position change Δq can occur in all possible directions; it depends on the numerical value of current velocity and position change which position change represents the worst case.

Stage 3 (figure 2) shows the pile after being stabbed and the hoist is fully slackened off. The tension forces in the puppet-weight-guidelines now stabilize the system in such a way that the pile will be kept in its (stable) equilibrium position with a slight deviation from the vertical because of currents and distance q. The system may now undergo various position changes Δq.

Before piledriving starts the vessel may change its position to obtain a vertical position of the pile (stage 4) or if required a batter one.
When the pile's position is within the required limits, the hammer will be started to operate while the Puppet Weight keeps pile and hammer upright. No dangerous shocks can be transferred into the hoist, nor in the puppet-weight-guidelines because of the slack in the hoist and the loosely guidance of the Puppet Weight around the pile. After some hammer blows the pile has penetrated the soil far enough to remain in its upright position, even without the Puppet Weight.

Figure 3 shows how the mechanical system works. For simplicity sake in first instance the following is assumed: (1) no friction between the puppet-weight-guidelines and the puppet-eyes, nor between the Puppet Weight and the pile; hence, the hoist force T is equal to G_3 cos α; (2) the vessel remains exactly vertically above the vessel (no position change of the vessel); (3) no currents, thus $F_D=0$; (4) the Puppet Weight remains at a constant level above the sea floor, thus distance l_3 is constant and independently of pile angle α. Suppose the system to be out of balance; let M_α be the moment of forces directed towards a positive value of α, relative to the toe side of the pile. From statics it follows (figure 3):

$$M_\alpha = (G_1 l_1 + G_2 l_2 + G_3 l_3)\sin\alpha + -G_3 l_0 . \sin(\alpha-\beta)(\cos\alpha) \quad (5)$$

$$\text{where } \beta = \arctan\left\{\frac{-l_0 . \sin\alpha}{h - l_0 . \cos\alpha}\right\}$$

For a sufficient large value of G_3 (which means a sufficient heavy Puppet Weight), this curve is similar to the curves shown in figure 4 (however, symmetrical with respect to the vertical axis).
The system is in equilibrium in the positions EP and UEP, where $M_\alpha = 0$. Position EP is the only stable Equilibrium Position; where in this symplification $\alpha = 0$. Positions UEP are Unstable Equilibrium Positions. The only relevant question in this stage is whether the stable Equilibrium Position EP exists or not. From mechanics (reference 4) it follows that the system remains stable as long as $\frac{dM_\alpha}{d\alpha} < 0$, where M_α is the moment of forces directed towards a positive value of α.

Derivation and linearization (small values of α) of equation (5) gives for the equilibrium position where $M_\alpha = 0$ and $\alpha = 0$:

$$\frac{dM_\alpha}{d\alpha} = (G_1 l_1 + G_2 l_2 + G_3 l_3)\,\alpha - \frac{G_3 . l_0 . h}{h - l_0} \quad (6)$$

Hence, the equilibrium position where $\alpha = 0$ is stable if:

$$\boxed{G_3 > \frac{(G_1 l_1 + G_2 l_2)\,(1 - l_0/h)}{l_0 - l_3(1 - l_0/h)}} \quad (7)$$

This simple equation specifies the minimum required Puppet Weight to make the system self-stabilizing. Because of the simplifications mentioned earlier in this paragraph, this equation may only be used to assess an approximation of the required Puppet Weight; a full analysis taking into account all mentioned aspects will answer the question wether a given Puppet Weight stabilizes the system properly.

In appendix A the moment of forces M_α has been derived, taking into account friction forces in the system, position changes of the vessel, currents and changes of l_3 due to a pile angle α. Figure 4 shows the moment of forces M_α for a certain example (not specified further in this paper). When the friction forces in the system are taken into account there are two curves; one because of a downward movement of the vessel and a second one for an upward movement. In this graph the points EP, UEP, RS and URS are the important ones. Point EP is the only (stable) Equilibrium Position of the system, because of $\frac{dM_\alpha}{d\alpha} < 0$.
A small devation of the system away from this position will

always cause a moment M_α that will direct the system back towards position EP.
Points UEP are Unstable Equilibrium Positions of the system; these points have no practical value. Points RS are to be looked upon as Re-Stab positions.
If for some reason pile angle α would reach one of these positions, the system will not regain automatically its (stable) equilibrium position EP when the vessel moves upwardly at that same moment; the pile must be lifted and be re-stabbed again. Does the vessel show a downward movement at that particular moment, re-stabbing could theoretically be put off until the system reaches point URS, being an Utmost Re-Stab position. In practice, however, only the position EP and RS are of interest. The other points (UEP and URS) therefore will not be considered any further in this paper.

A computer program is available to assess the points EP, RS and URS. Appendix B shows a Puppet System Analysis Sheet, available to be filled in.

NOMENCLATURE

f_1 = friction coefficient between puppet-eyes and puppet-weight-guidelines

f_3 = friction coefficient between Puppet Weight and pile

F_D = resultant of drag forces on pile and hammer

G_1 = weight of hammer in water

G_2 = weight of pile in water

G_3 = weight of Puppet Weight in water

h = water depth

l_0 = height of puppet-eyes

l_1 = height of hammer's centre of gravity

l_2 = height of pile's centre of gravity

l_3 = height of Puppet Weight's centre of gravity for $\alpha = 0$

l_D = height of point of action of F_D

Δl_3 = increase of l_3 (appendix A)

M_α = moment of forces directed towards a positive value of α and relative to the toe side of the pile

q = horizontal distance between pile toe and vessel

Δq = increase of q due to a position change of the vessel

q_1 = q at pile landing (just before touch-down)

q_S = q just before pile stabbing

T = total of forces in puppet-weight-guidelines

W_1 = friction force due to f_1

W_3 = friction force due to f_3

α = pile angle measured from the vertical

α_1 = α at pile landing (just before touch-down)

α_s = α just before pile stabbing

β = angle of puppet-weight-guidelines, measured from the vertical

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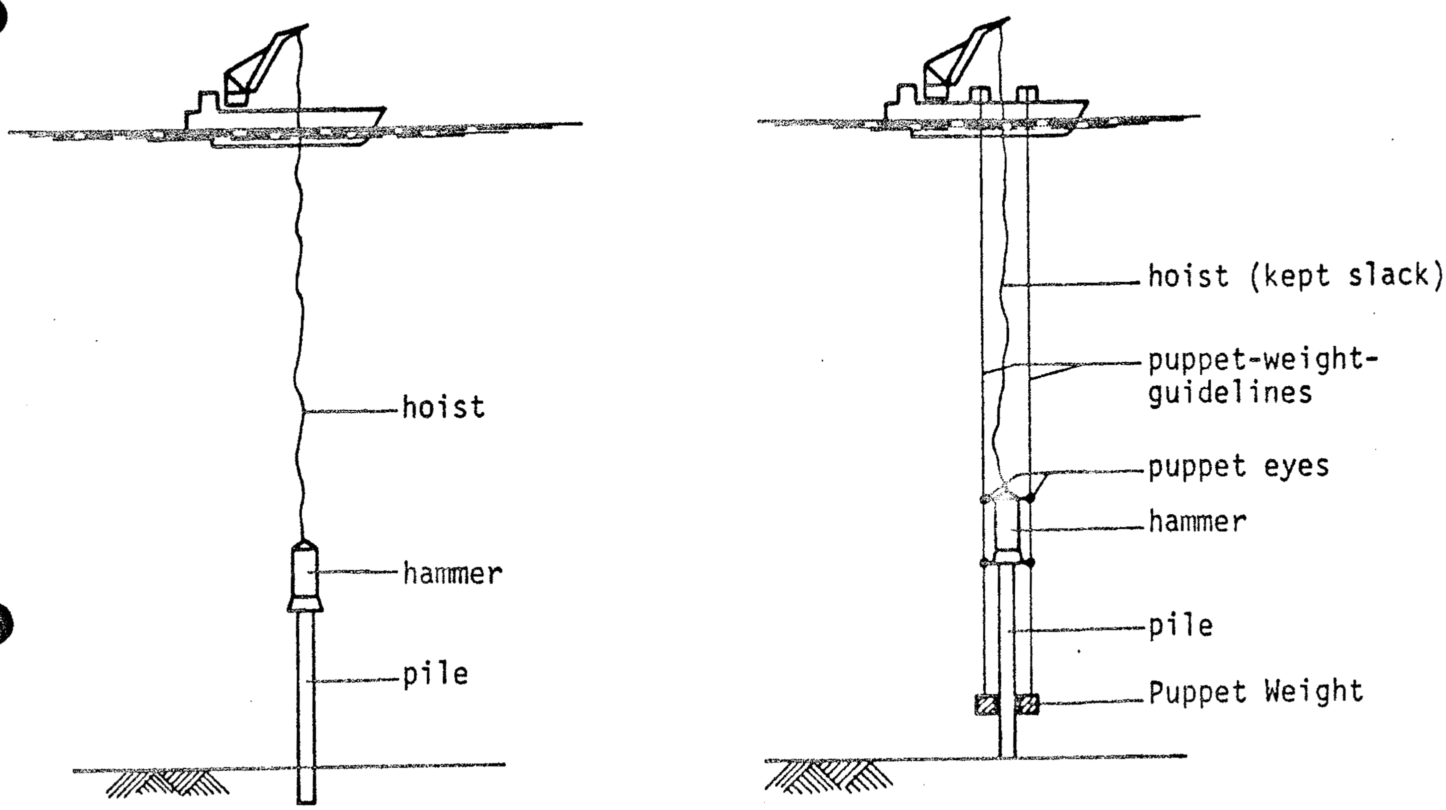
(3) JANSZ, J.W. and BROCKHOFF, H.S.T. "A simple Way to Drive Free-Standing Subsea Anchor Piles",to be presented at Offshore Technology Conference, 1979, OTC 3439

(4) BOTTEMA, O. "Theoretical Mechanics",(in Dutch) Scheltema & Holkema, Amsterdam, 1970, pp. 28-29



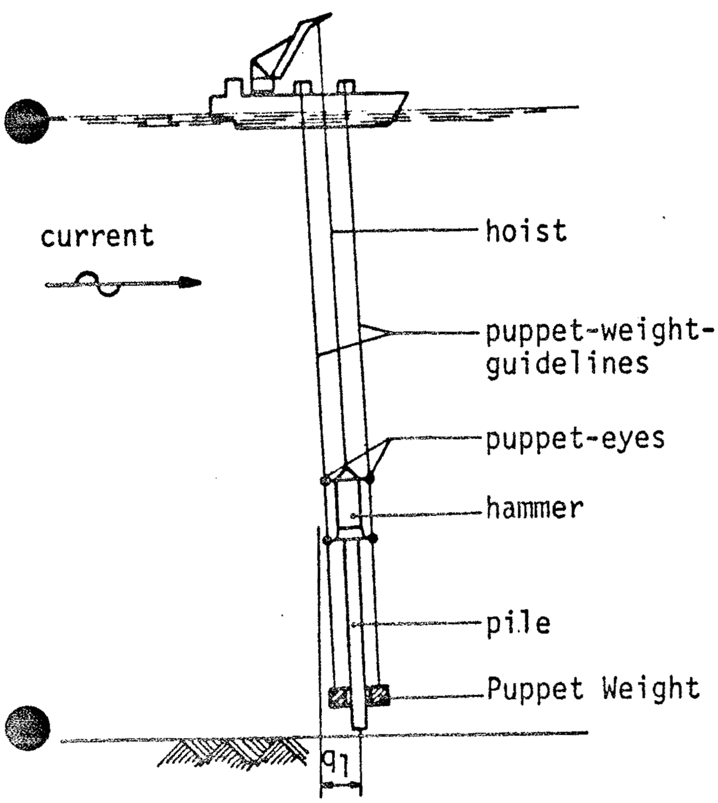
pile penetrates soil by selfweight and lateral soil resistance keeps pile and hammer upright

METHOD 1

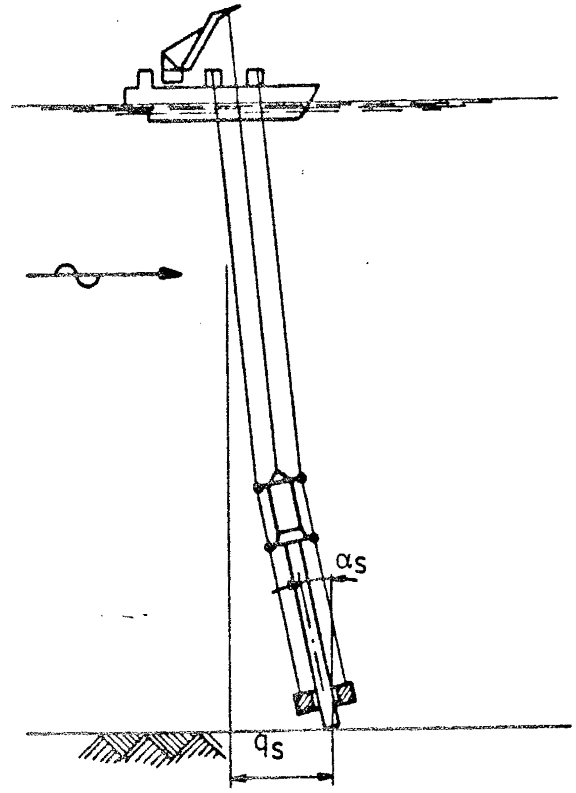
no lateral soil resistance (e.g. hard soil)

METHOD 2

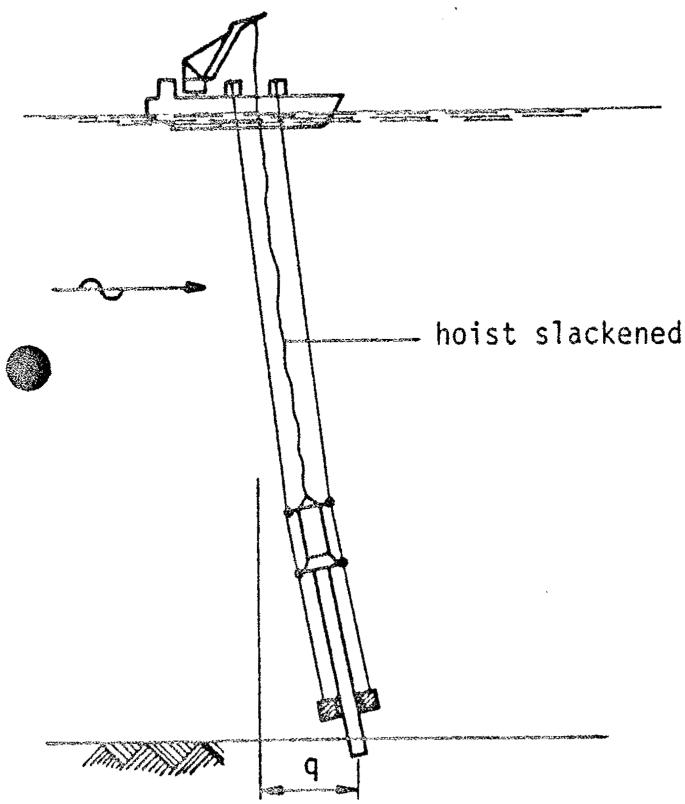
Figure 1: The Puppet Systems



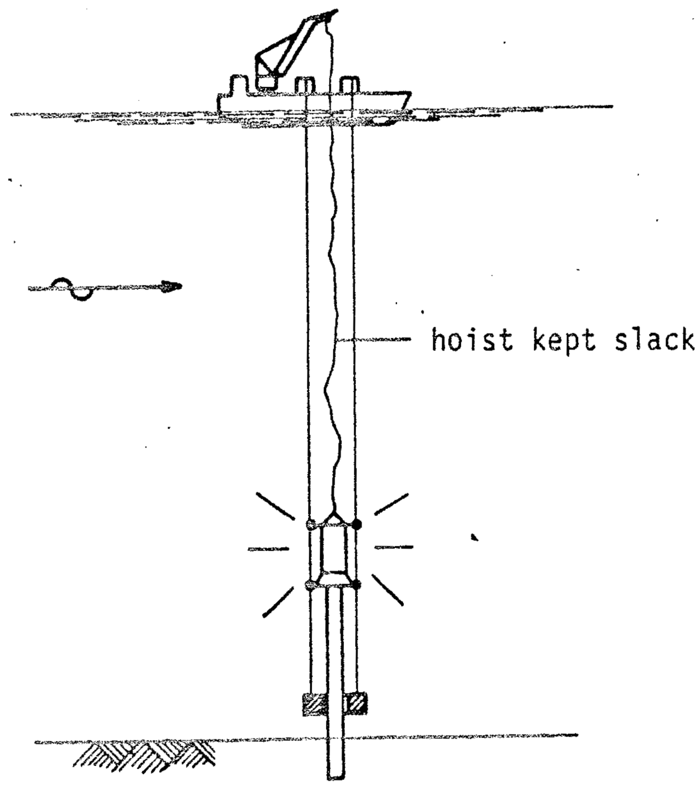
Stage 1: Pile, hammer and Puppet Weight just before landing on sea floor



Stage 2: Touch-down of pile toe; a position change of the vessel is assumed

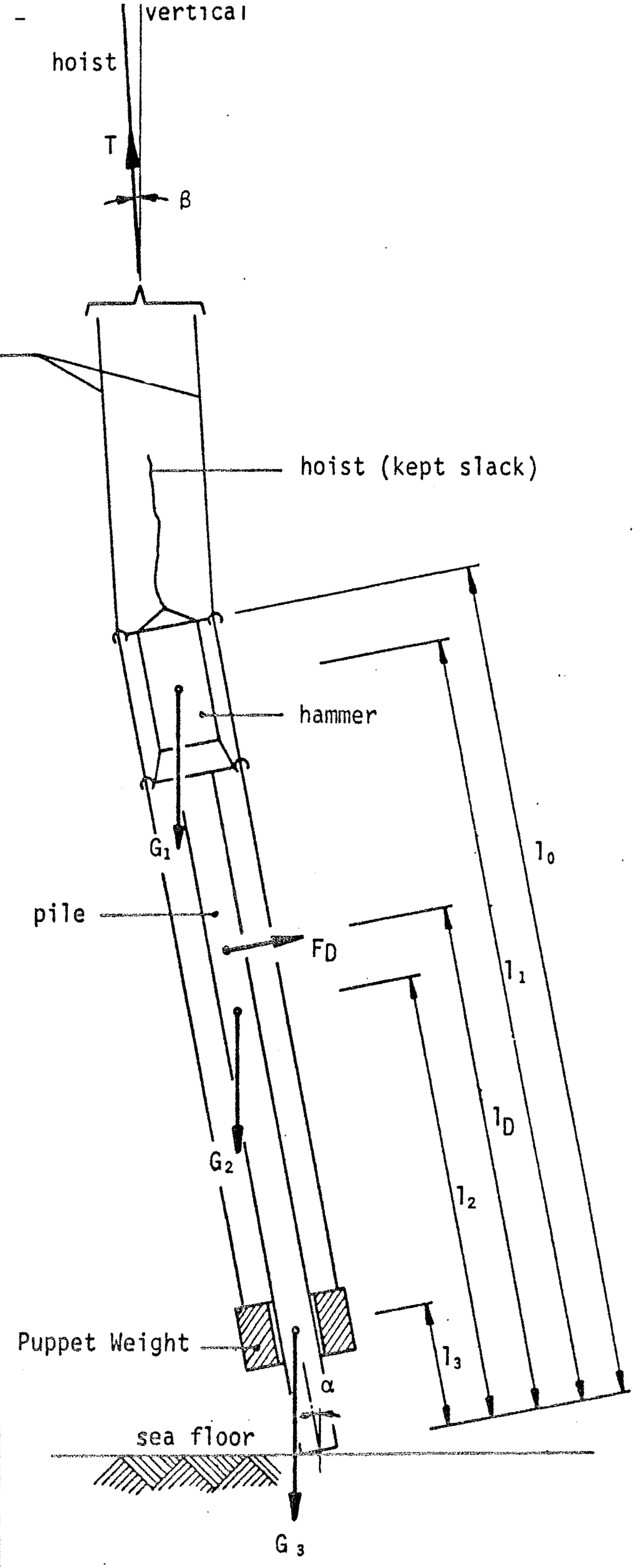


Stage 3: Hoist slackened off while Puppet Weight stabilizes pile and hammer



Stage 4: Vessel changes position to obtain a vertical pile position; hammer starts operating

Figure 2: Operation of the soil-independent Puppet System Number 2



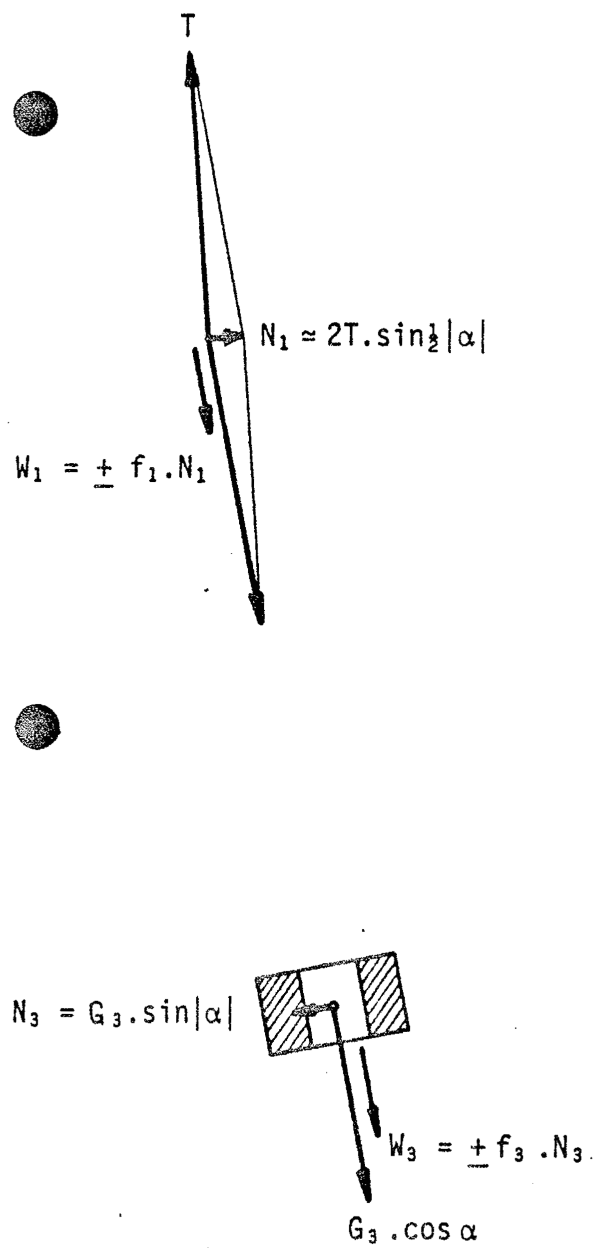
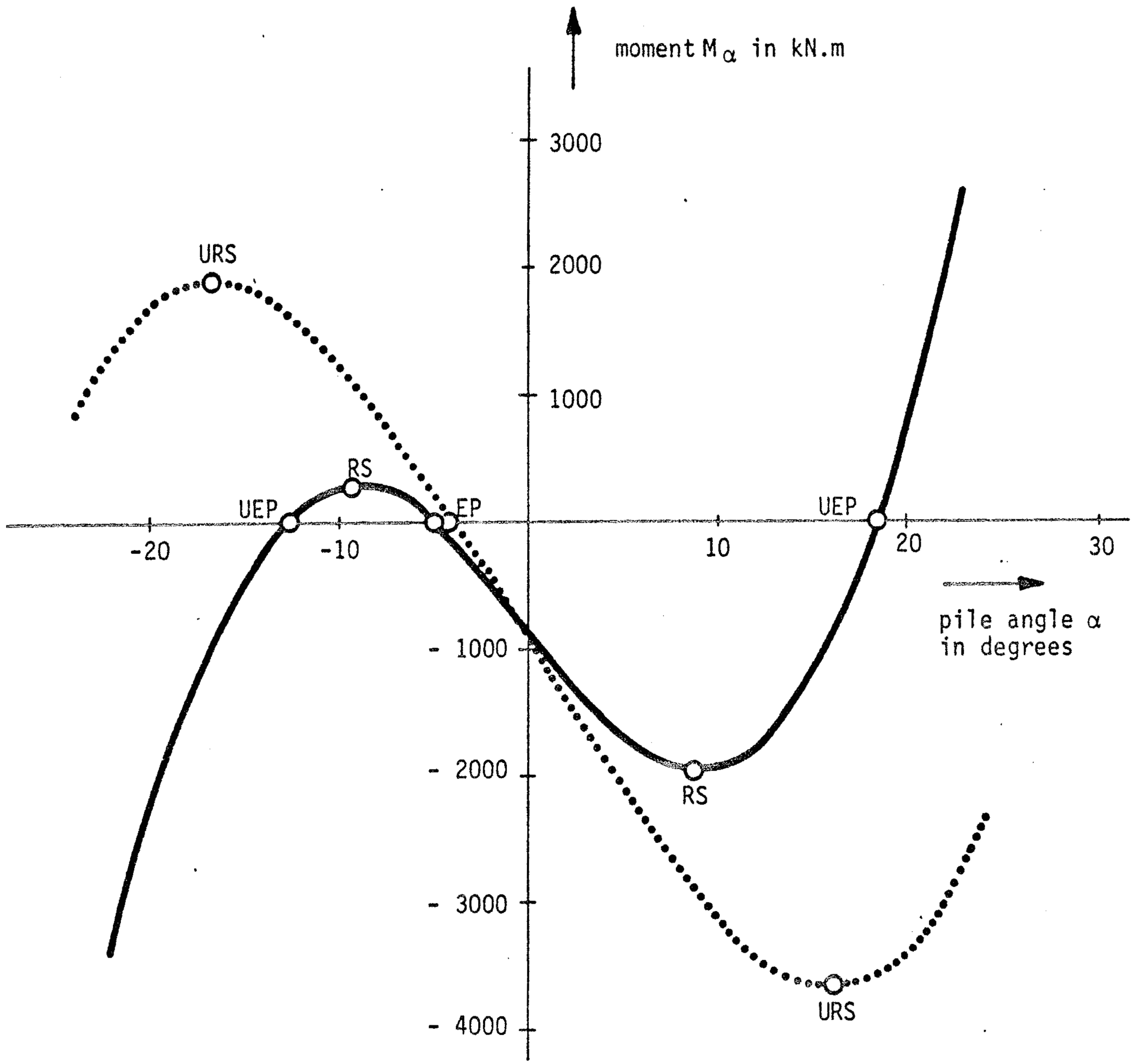


Figure 3A: Friction forces

Figure 3: Mechanical system of Puppet System Number 2



downward movement of the vessel

upward movement of the vessel

EP = (stable) Equilibrium Position
UEP = Unstable Equilibrium Position
RS = Re-Stab position
URS = Ultimate Re-Stab position

Figure 4: Puppet System Number 2; moment M_α versus pile angle α for certain example

MOMENT OF FORCES FOR PUPPET SYSTEM NUMBER 2

See figure 3. Let M_α be the moment of forces directed towards a positive value of α and relative to the pile toe. From statics it follows:

$$M_\alpha = \{G_1.l_1 + G_2.l_2 + G_3(l_3 + \Delta l_3)\} \sin\alpha +$$

$$- F_D.l_D - T.l_0.\sin(\alpha-\beta) \qquad \text{(B1)}$$

where: $\Delta l_3 = l_0 - h + \dfrac{h - l_0.\cos\alpha}{\cos\beta}$

and: $\beta = \arctan\{\dfrac{q - l_0.\sin\alpha}{h - l_0.\cos\alpha}\}$

From figure 3A:

$$W_1 \simeq \pm 2f_1.T.\sin\tfrac{1}{2}|\alpha| \qquad \text{(B2)}$$

$$W_3 \simeq \pm f_3.G_3.\sin|\alpha| \qquad \text{(B3)}$$

From equilibrium of forces in the puppet-weight-guidelines:

$$T = G_3.\cos\alpha + W_1 + W_3 \qquad \text{(B4)}$$

W_1, W_3 and T can be eliminated from the four equations (B1), (B2), (B3) and (B4); further substitution of Δl_3 leads to M_α as a function of known parameters and pile angle α:

$$M_\alpha = G_1.l_1 + G_2.l_2 - F_D.l_D +$$

$$+ G_3\{l_3+l_0-h + \frac{h-l_0.\cos\alpha}{\cos\beta}\} \sin\alpha +$$

$$- G_3.l_0\{\frac{\cos\alpha \pm f_3.\sin|\alpha|}{1-(\pm 2f_1.\sin|\tfrac{1}{2}\alpha|}\} \sin(\alpha-\beta) \qquad \text{(B5)}$$

where: $\beta = \arctan\{\dfrac{q-l_0.\sin\alpha}{h-l_0.\cos\alpha}\}$

The $\pm$ sign in these equations to be chosen positive for an upward movement of the vessel and negative for a downward one.

PUPPET SYSTEM ANALYSIS SHEET

INPUT

Sea
Water depth
or Current at hammer level at touch down
or Current at surface – – – – – – – – –
Current near sea-bottom

Vessel
Type (e.g. barge, drillship)
Positioning method (e.g. anchors, dynamically)
Expected position changes of vessel

Pile
Steel, circular cross section, hollow, open-ended:
Outside diameter
Whall thickness
Length – – – – –

or

Pile
Other types:
Type (e.g. square, circular, two parts)
Length – – – – –
Weight above water
Water displacement
Frontal area (for current forces)

Hammer
please circle appropriate type:
HBM 500/HBM 900/HBM 1500/HBM 3000A/ HBM 4000

RESULTS

Puppet Weight: steel, weight above water ton

Pile landing distance q_ℓ m Pile landing angle α_ℓ deg	upstream position change	downstream position change	position change perpendicul. to current
Pile stabbing distance q_s Pile stabbing angle α_s	m deg	m deg	m deg
Equilibrium Position EP	deg	deg	deg
Re-Stab positions RS	deg deg	deg deg	deg deg
Ultimate Re-Stab positions URS	deg deg	deg deg	deg deg
Smallest angle between EP and RS	deg	deg	deg

computer run nr: executed by: verified by:

hydroblok
hollandsche beton maatschappij bv
p.o.box 82 - rijswijk - the netherlands.

HYDROBLOK references:

(1) JANSZ, J.W.; ARENTSEN, D.; BOMER, H. and VOITUS van HAMME, G.E.J.S.L. "Piledriving with the Hydroblok", De Ingenieur, 86 (1974), pp. 146-153

(2) VOITUS van HAMME, G.E.J.S.L.; JANSZ, J.W.; BOMER, H. and ARENTSEN, D. "Hydroblok and improved piledriving analysis", De Ingenieur, 86 (1974), pp. 345-353

(3) JANSZ, J.W. "Underwater Piledriver for 1000-ft Depth", Ocean Engineering, 1975, November 15, pp. 68-76

(4) COX, B.E. and CHRISTY, W.W. "Underwater Pile Driving Test Offshore Louisiana", Offshore Technology Conference 1976, OTC 2478

(5) JANSZ, J.W.; VOITUS van HAMME, G.E.J.S.L.; GERRITSE, A. and BOMER, H. "Controlled Piledriving Above and Under Water With A Hydraulic Hammer", Offshore Technology Conference 1976, OTC 2477

(6) JANSZ, J.W. "North Sea Pile Driving Experience With a Hydraulic Hammer", Offshore Technology Conference 1977, OTC 2840

(7) HUSSEN, K. van "Submarine Piledriving for Deepwater Installations", Ocean Resources Engineering, September 1977, pp. 60-65

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(9) JANSZ, J.W. "Subsea Piledriving: A Breakthrough", Petroleum Engineering, June 1978, pp. 76-86

(10) "Cognac Launch Technology An Offshore Landmark", Offshore Engineer, October 1978, pp. 18-20

(11) JANSZ, J.W. and BROCKHOFF, H.S.T. "Unsupported Underwater Piledriving; Part 1: Theory and North Sea Experience", Ocean Resources Engineering, December 1978, pp. 8-12

(12) "Controlled Hydraulic Piledriving". Consulting Engineer , January 1979, pp 48-52

(13) JANSZ, J.W. and BROCKHOFF, H.S.T. "Unsupported Underwater Piledriving; The Soil Independent Puppet System", to be published in Petroleum Engineer International, 1979

(14) JANSZ, J.W. and BROCKHOFF, H.S.T. "A simple Way to Drive Free-Standing Subsea Anchor Piles", to be presented at Offshore Technology Conference, 1979, OTC 3439

(15) JANSZ, J.W. "Underwater Piledriving; Todays Experience and What is About to Come", to be presented at Second International Conference on Behaviour of Off-Shore Structures, August 1979

HYDROBLOK
UNDERWATER PILEDRIVING

VEROLME ENGINEERING COMPANY
Hydroblok organisation
P.O.Box 5079
Rotterdam - THE NETHERLANDS
phone (10) 825300 telex 28962
Please refer to projectnr. 79083.

prepared for
Brown & Root, Inc.

Note: Only proven conceptions are proposed herein.

• INTRODUCTION

PART 1

THIS SET OF SKETCHES INDICATES THE ALTERNATIVE POSSIBILITIES OF HYDROBLOK HANDLING

• CONTENTS

• SHEET S1 INDICATES THE SITUATION AS WE ASSUMED
ALL BASIC ITEMS FOR HYDROBLOK DRIVING ARE INDICATED
ITEMS INDICATED BY A QUESTIONMARK ARE SUBJECT TO DISCUSSION

PART 2

• Sheet 0400.00 - 130 UP TO AND INCL 152
GENERAL PILE - AND HAMMER HANDLING

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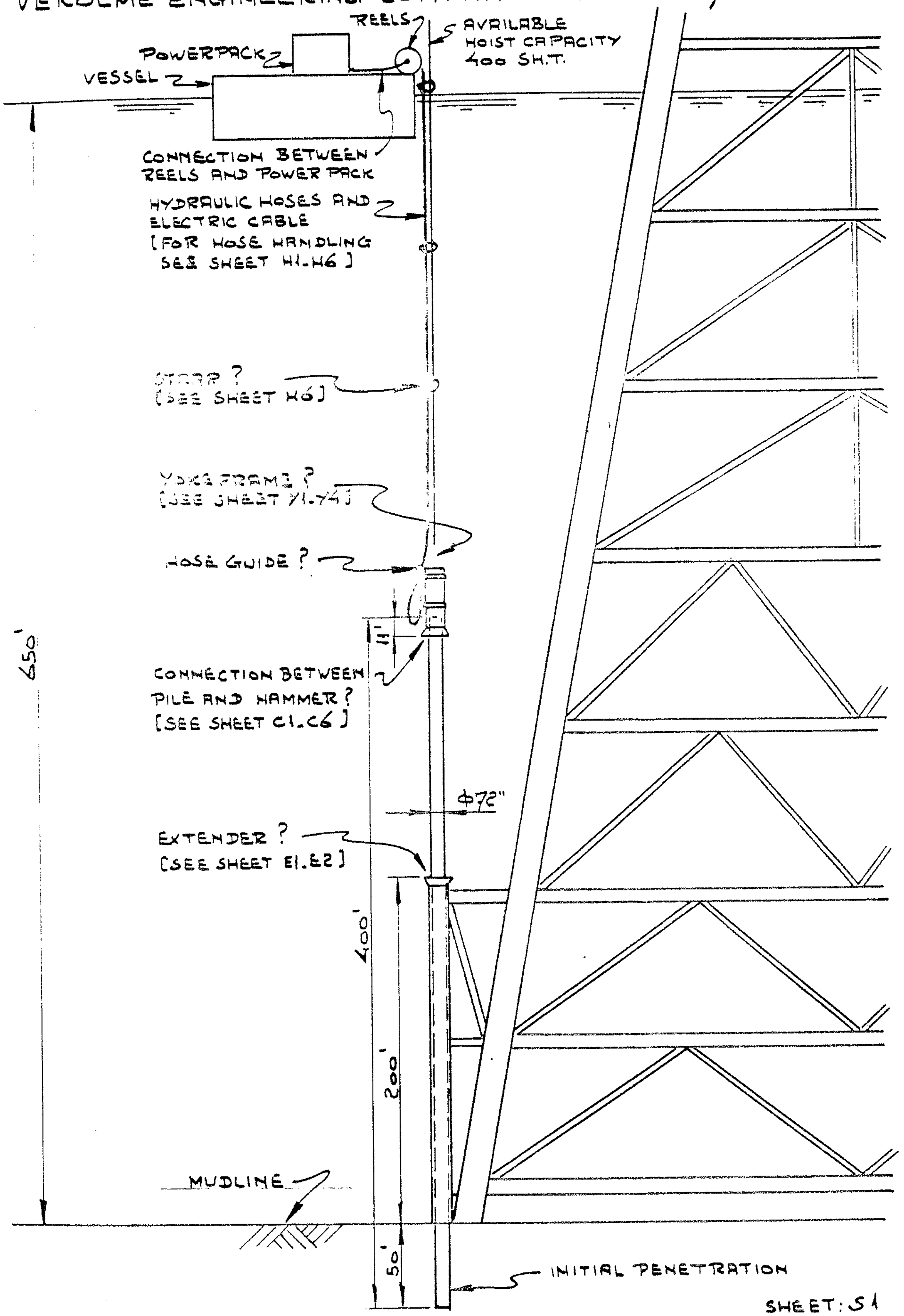
SITUATION BROWN & ROOT

VEROLME ENGINEERING COMPANY PROJECT: 79083



SHEET: S1

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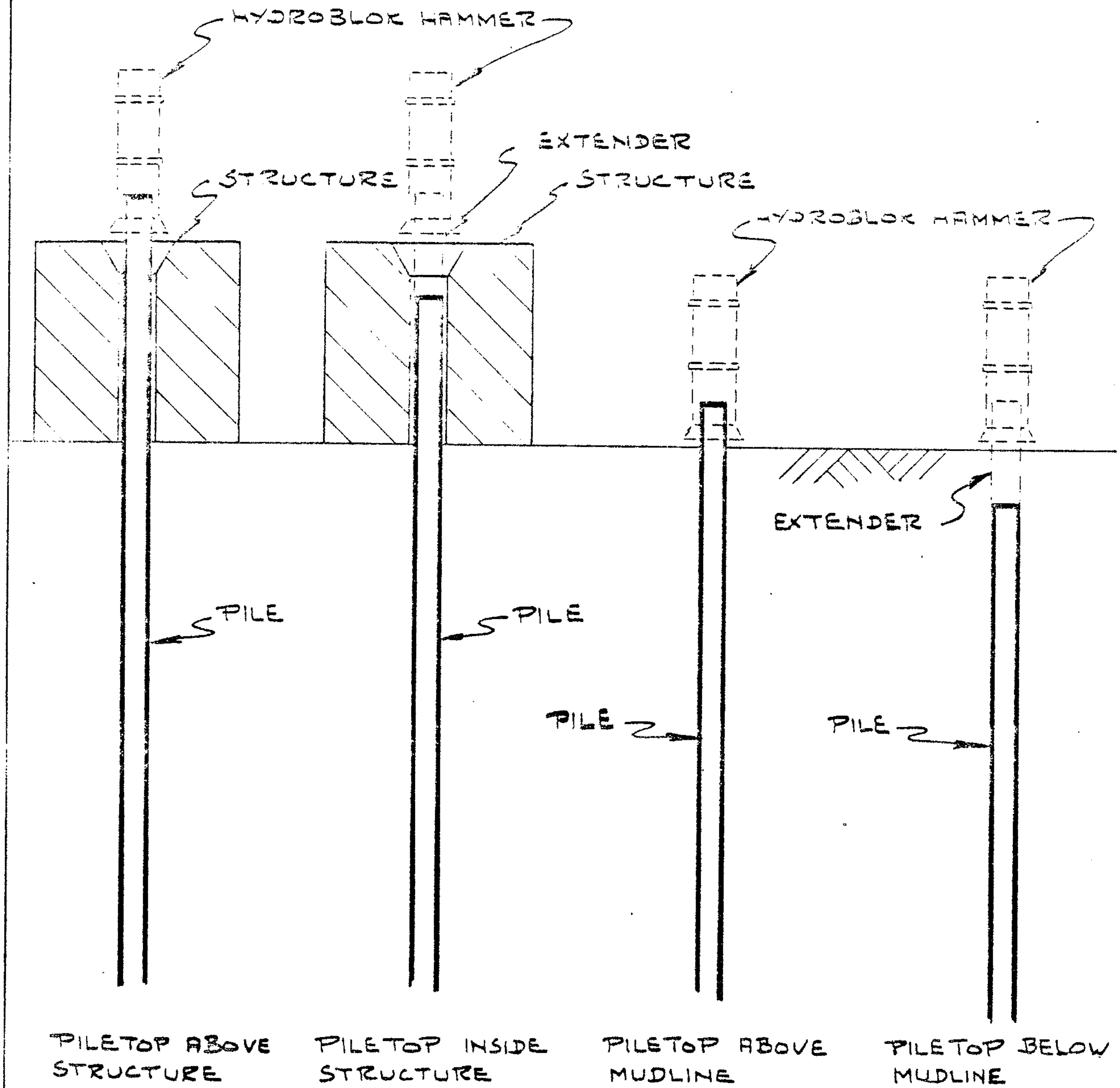
APRIL '79

HYDROBLOK DRIVING SYSTEMS USING THE EXTENDER



SEE ALSO SHEET: E2

SHEET: E1

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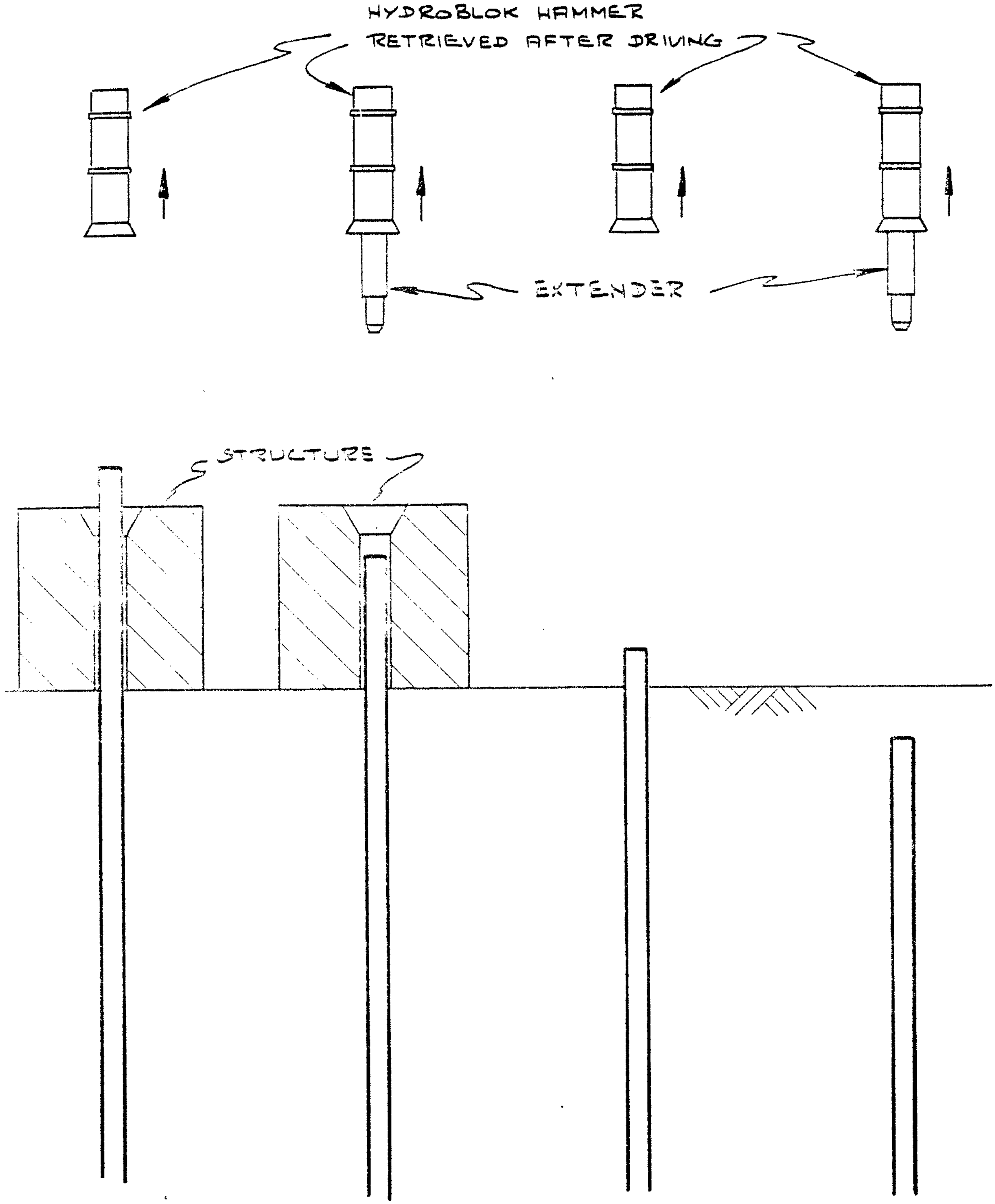
HYDROBLOK DRIVING SYSTEMS : WITH/WITHOUT THE USE OF THE EXTENDER



PILES DRIVEN TO FINAL PENETRATION

SHEET: E2

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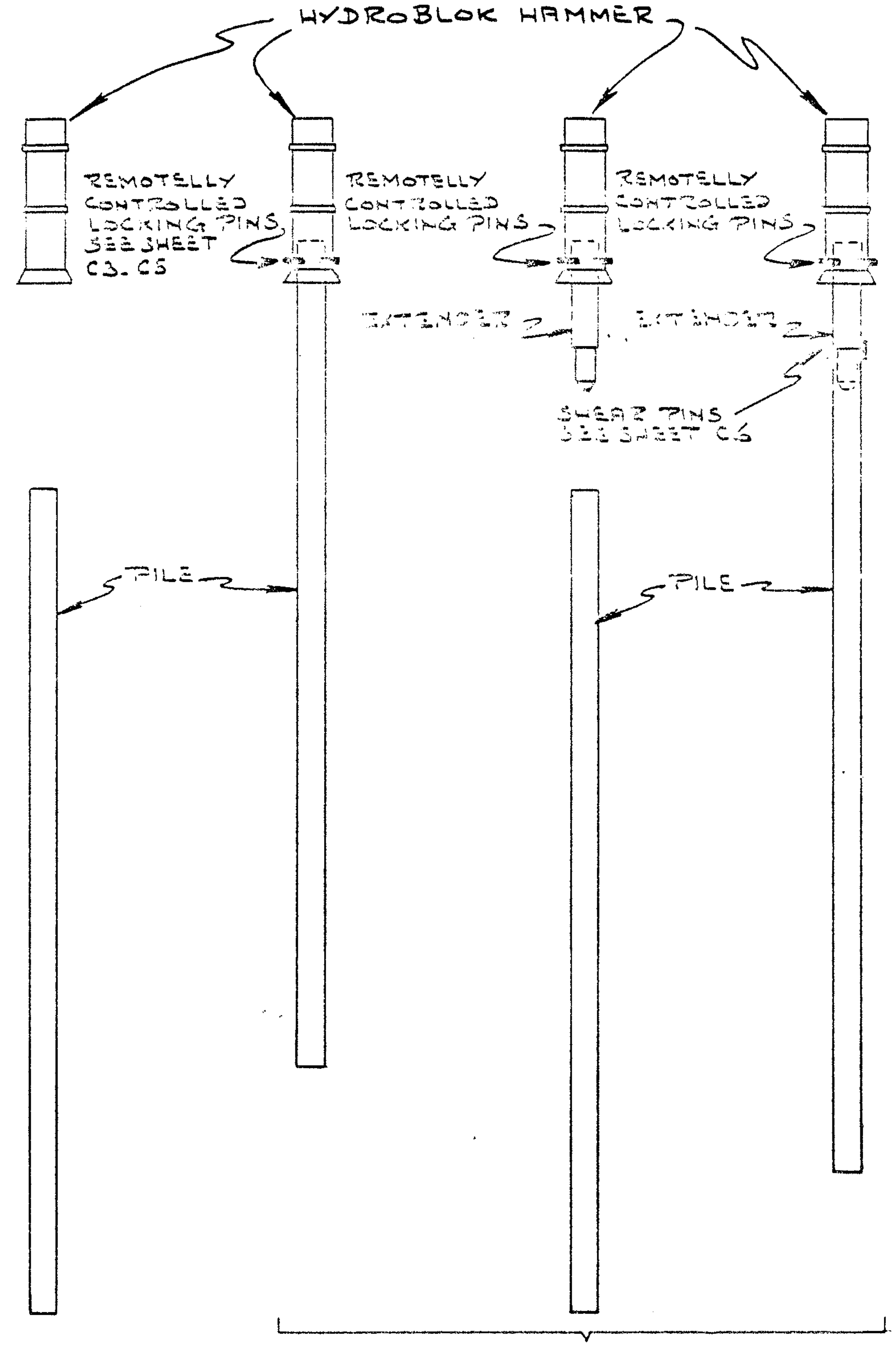
APRIL '79

HOW TO CONNECT PILE, EXTENDER AND HYDROBLOK HAMMER

SUCH CONNECTIONS CAN BE USED WHEN HYDROBLOK HAMMER, EXTENDER AND/OR PILE ARE JOINTLY LOWERED TO SEAFLOOR



NO CONNECTION

CONNECTION BY LOCKINGPIN OR SHEARPIN [DIVERLESS DISCONNECTING]

SHEET: C1

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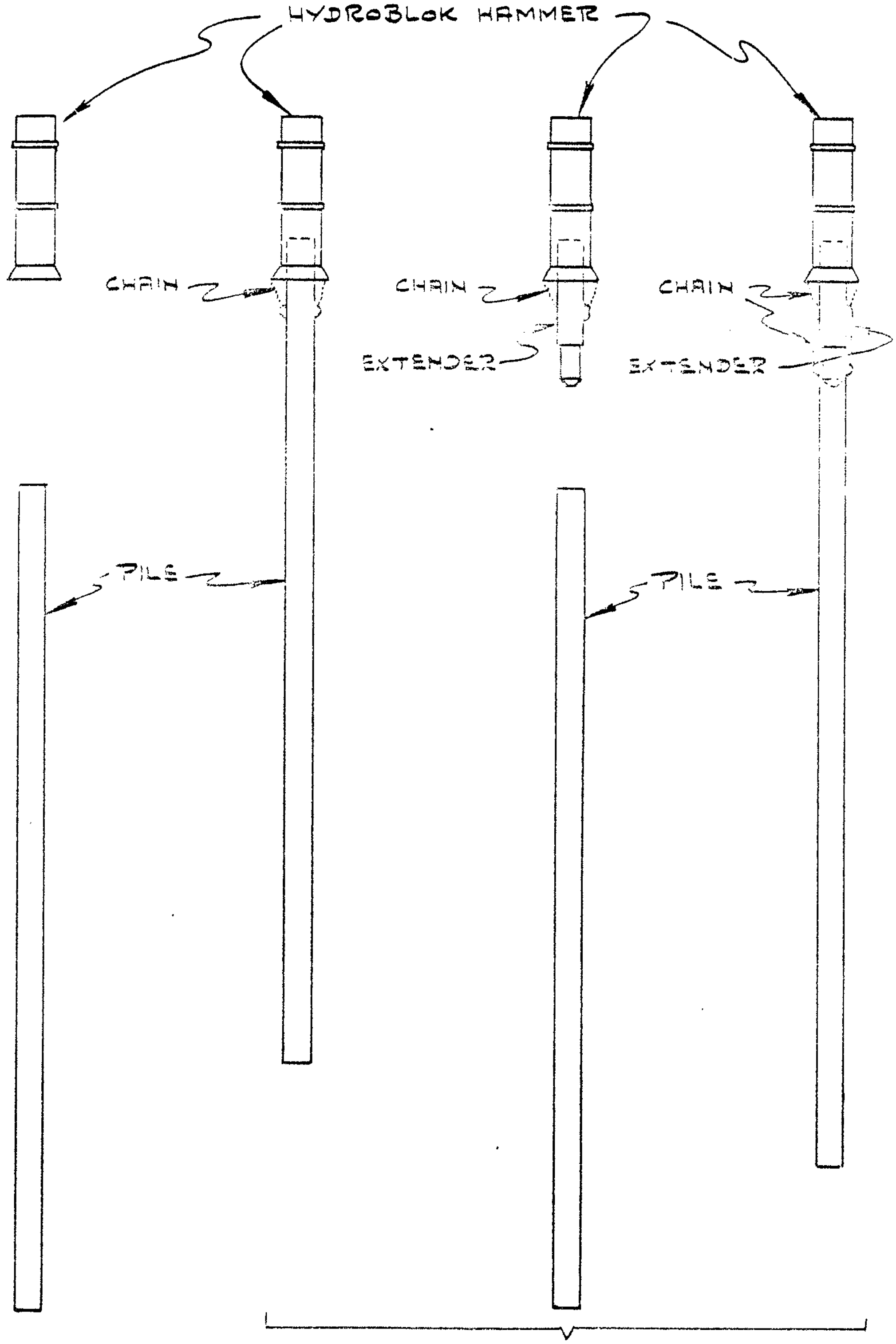
APRIL '79

CHAINCONNECTION BETWEEN PILE, EXTENDER AND HYDROBLOK HAMMER.



NO CONNECTION

CONNECTION BY CHAINS
AFTER DRIVING DISCONNECTION OF CHAINS
[BY DIVERS?]

SHEET: C2

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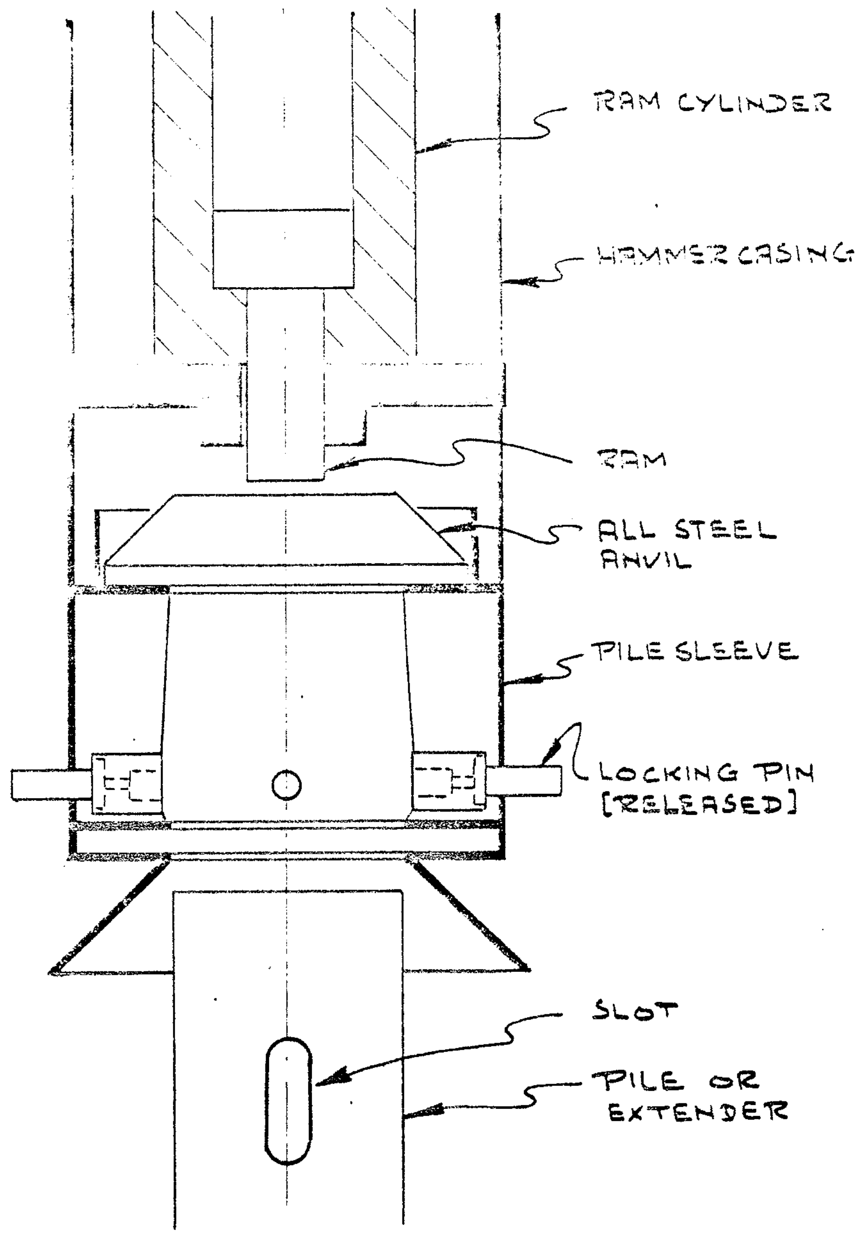
- LOCKING PINS RELEASED [REMOTELY CONTROLLED]
- HYDROBLOK HAMMER LIFTED FROM PILETOP



RETRIEVING OF HAMMER WITHOUT PILE OR EXTENDER

SHEET: C3

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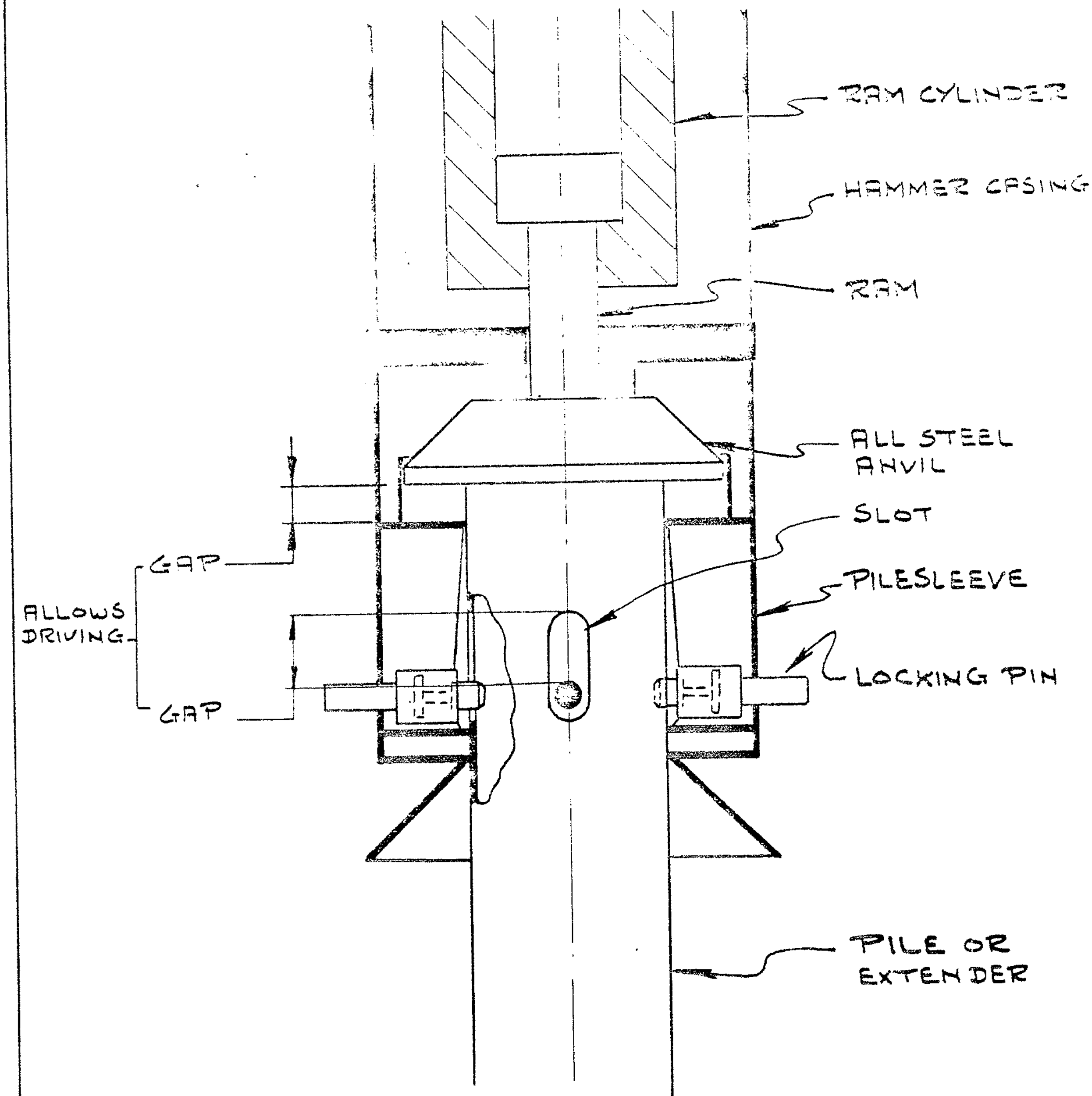
APRIL '79

- HYDROBLOK HAMMER SITS FREELY ON TOP OF PILE
- PILE SUPPORTS HAMMER
- LOCKING PINS [GRIPPING] ARE FREE OF THE PILE



SITUATION AFTER STABBING; READY FOR DRIVING

SHEET: C4

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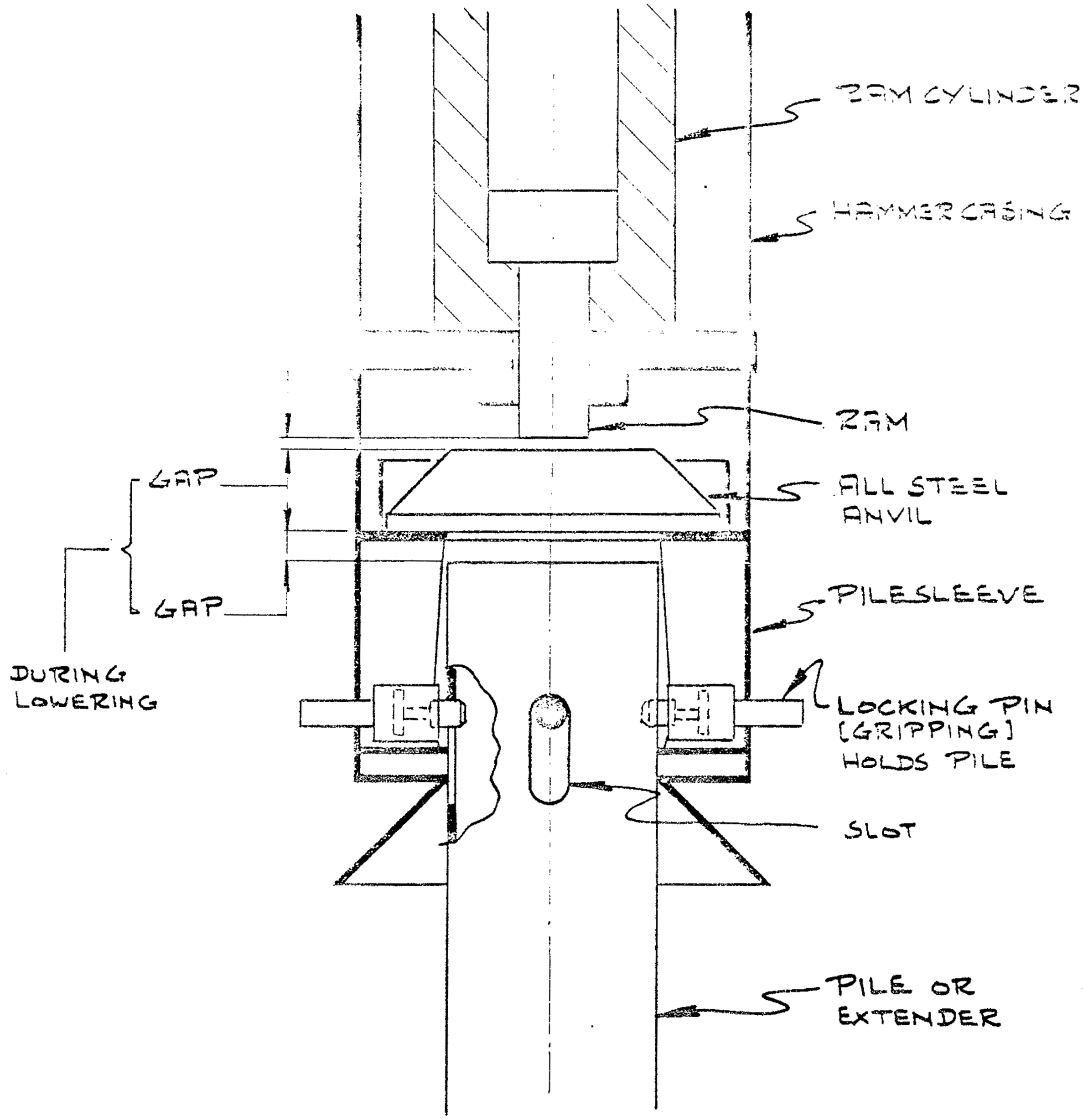
LOCKING PINS IN PILESLEEVE

- PILE IS SUPPORTED BY THE LOCKING PINS
- ANVIL RESTING ON PILESLEEVE
- GAP BETWEEN RAM AND ANVIL
- GAP BETWEEN ANVIL AND PILETOP



SITUATION DURING LOWERING TO SEAFLOOR

SHEET: C5

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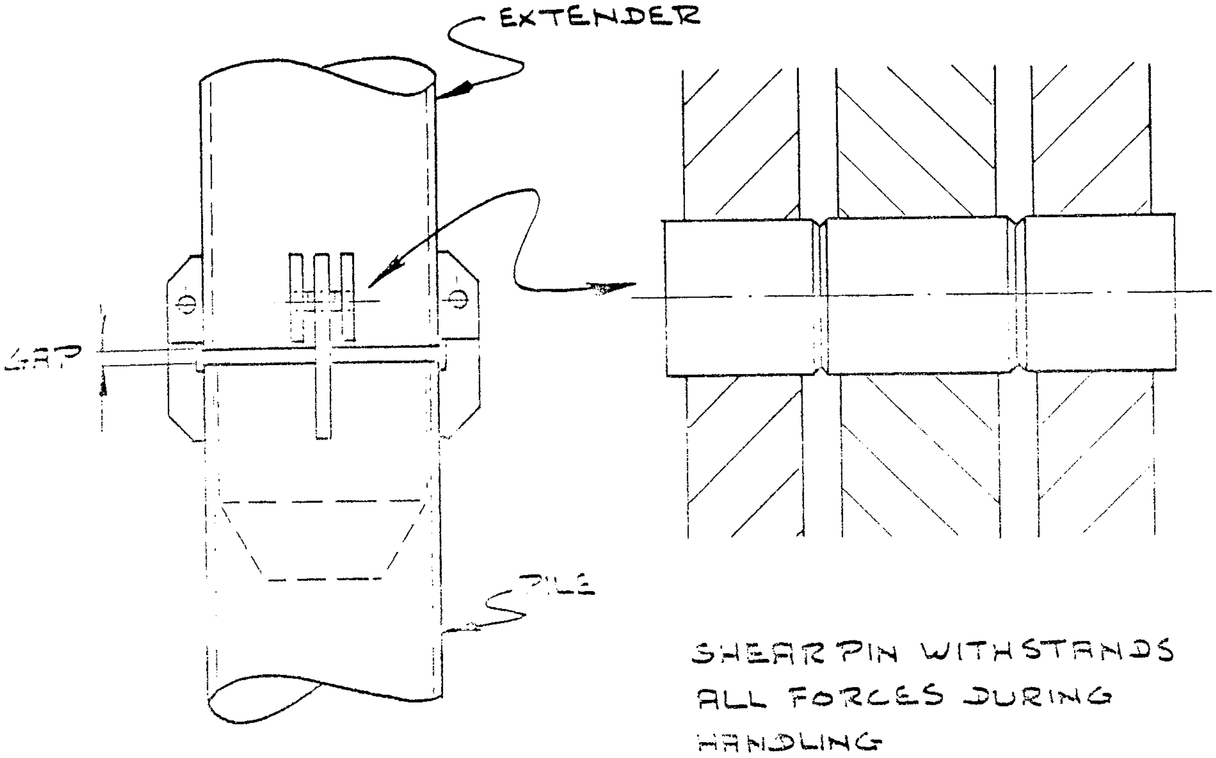
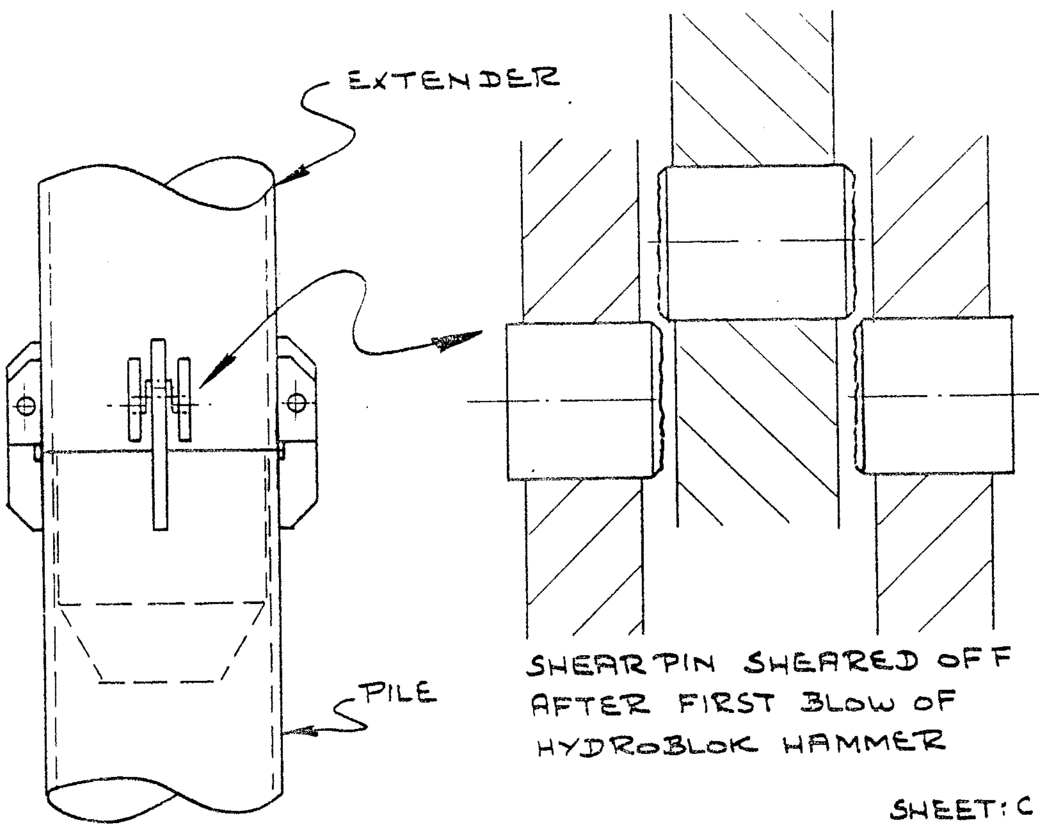
APRIL '79

SHEARPIN CONNECTION BETWEEN EXTENDER AND PILE





SHEET: C6

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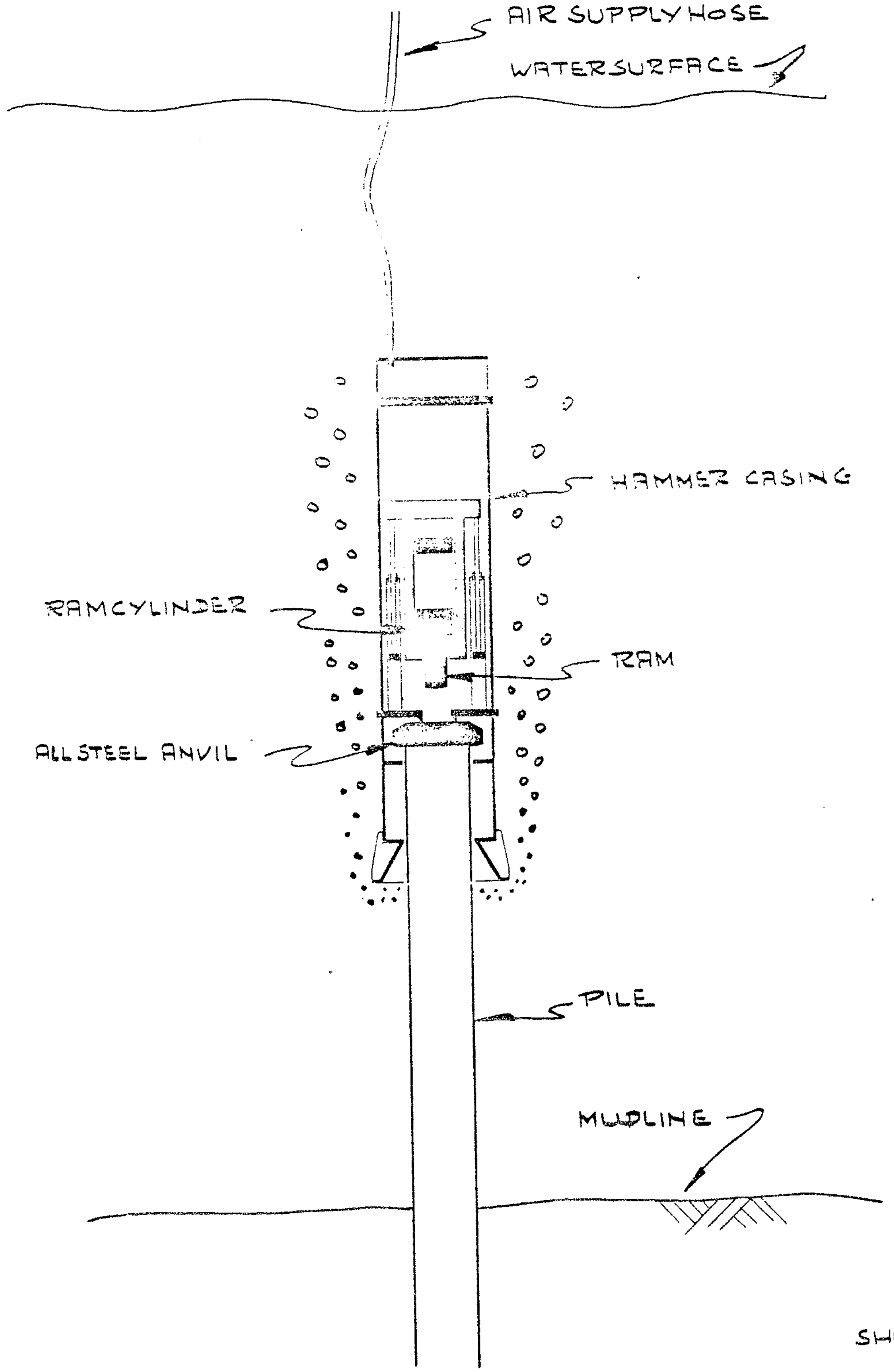
APRIL '79

HYDROBLOK DRIVING UNDER WATER, USING THE HAMMERCASING AS A DIVING BELL



SHEET: G 1

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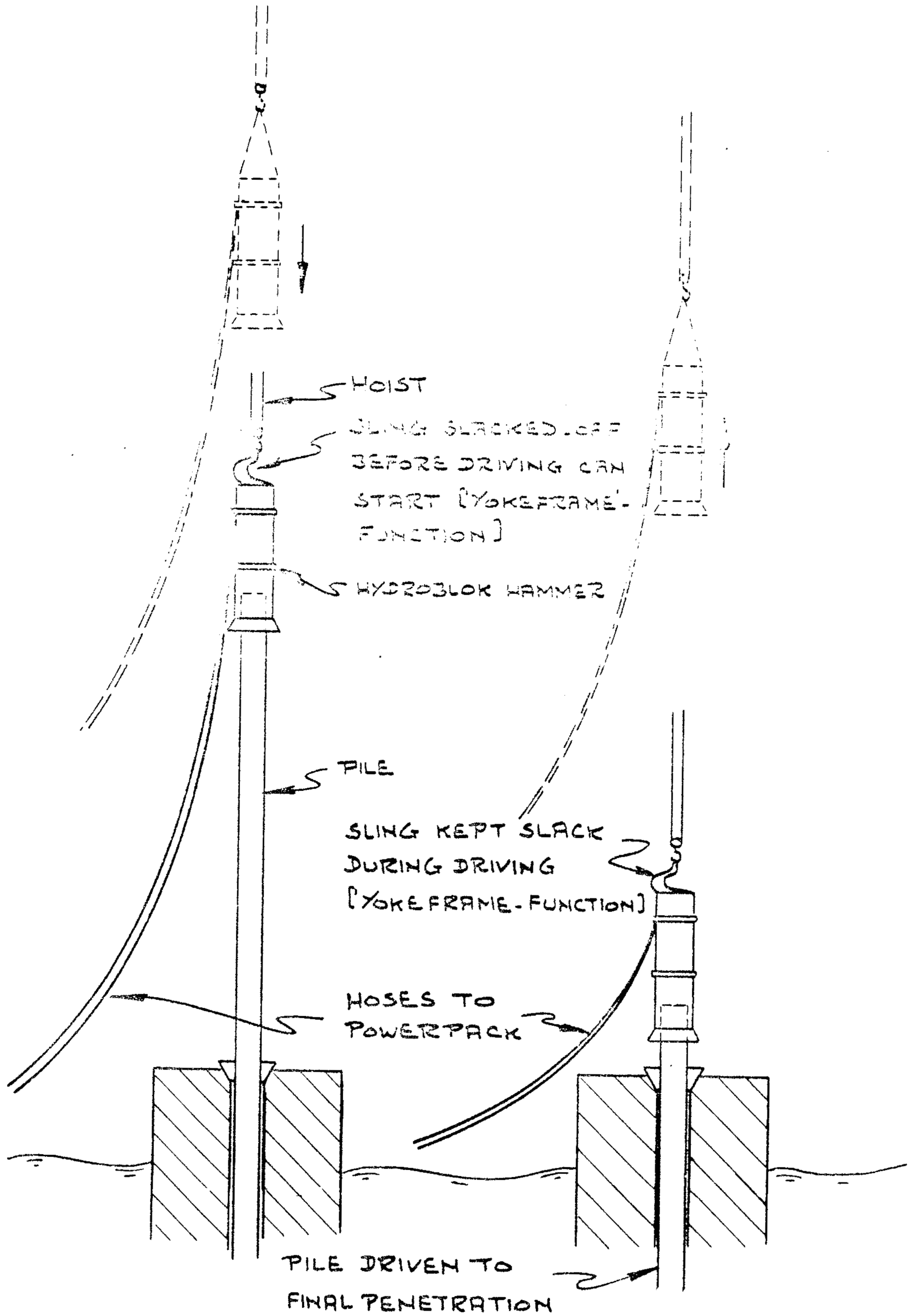
HYDROBLOK DRIVING ABOVE WATER



SHEET: H1

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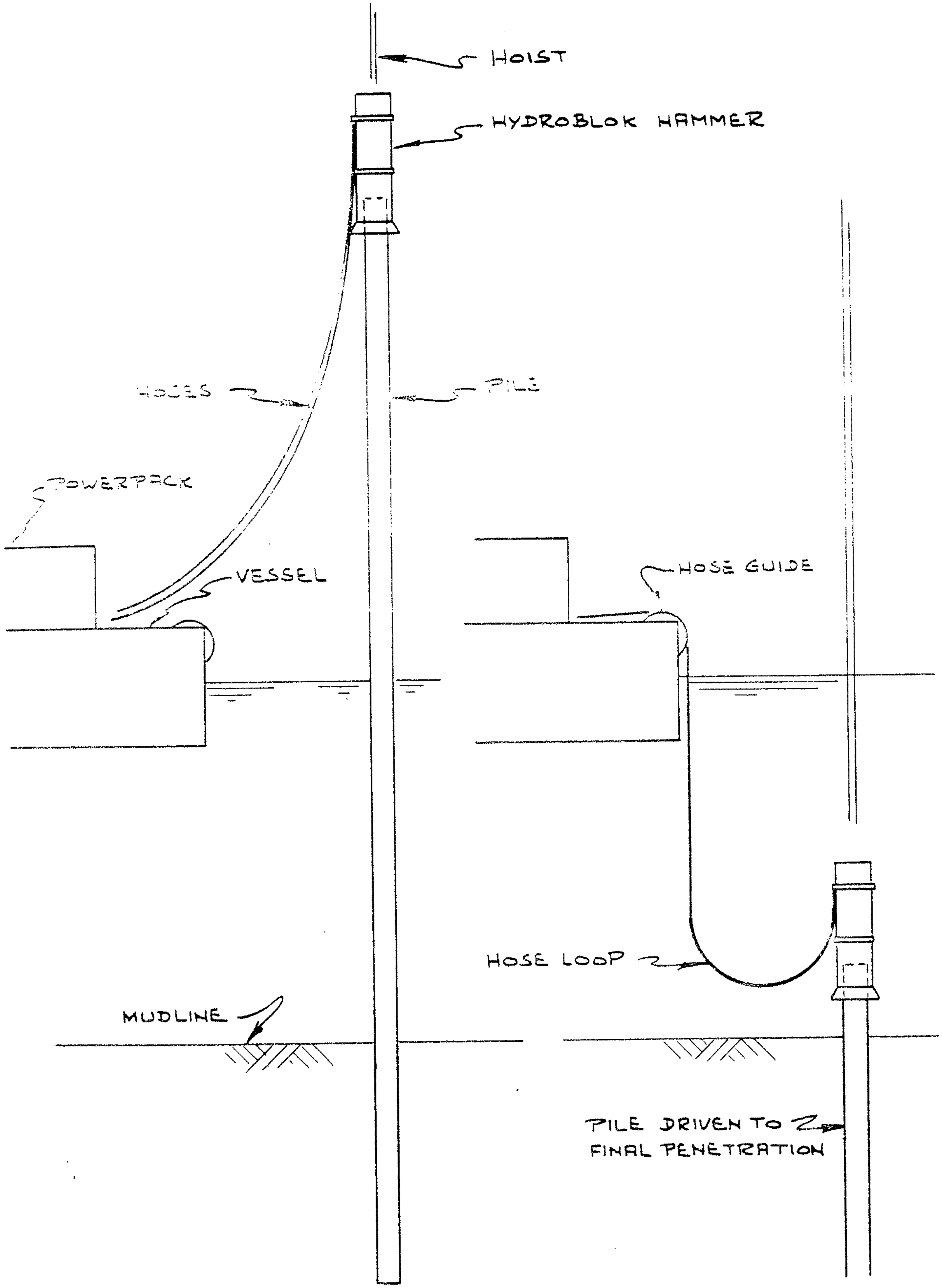
APRIL '79

UNDERWATER DRIVING WITH FIXED HOSELENGTH



SHEET: H2

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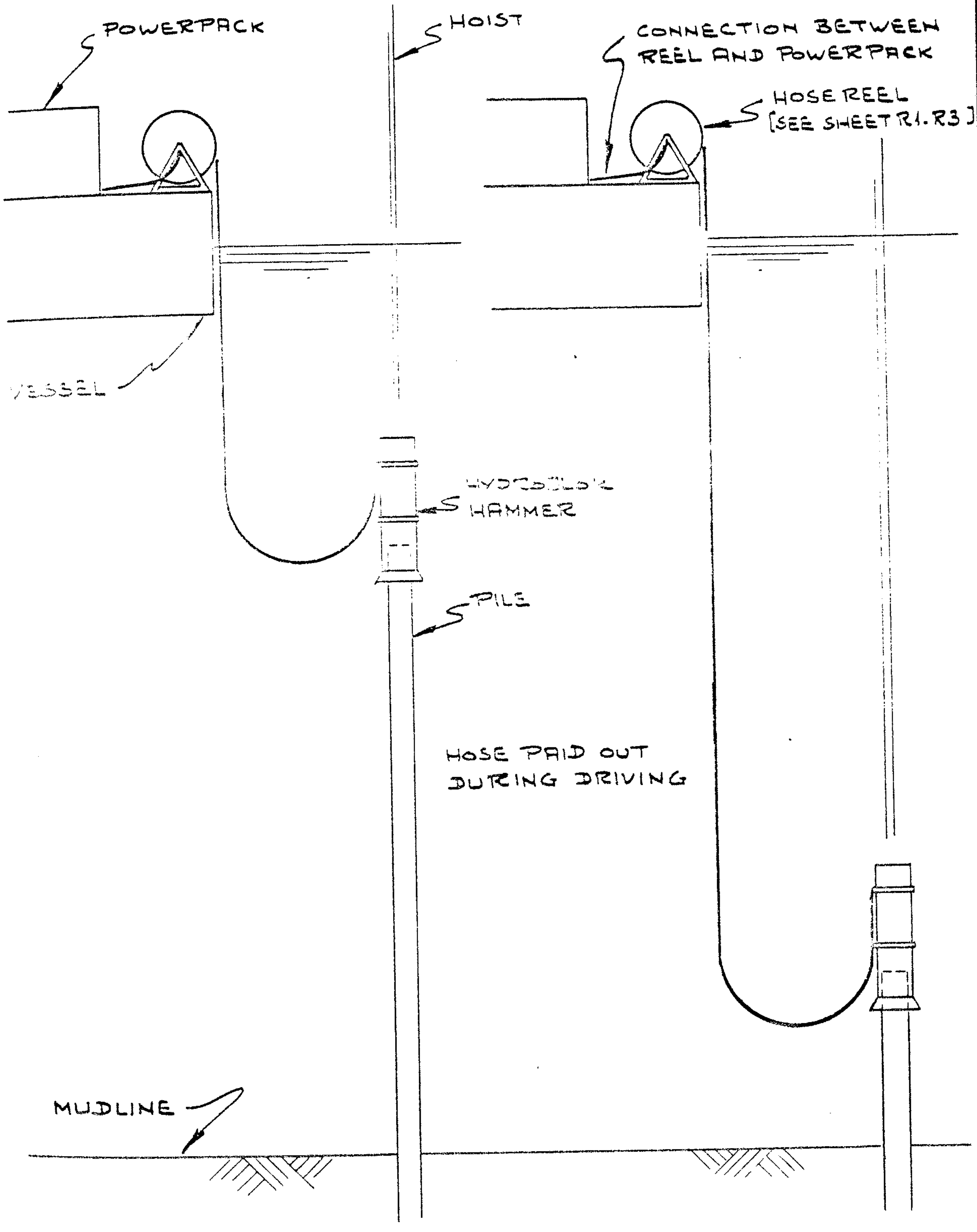
UNDERWATER DRIVING WITH VARIABLE HOSELENGTH PAID OUT



NOTE: DEPTH MEASURING PROVISIONS FOR HOSEREEL CONTROL ARE NOT INDICATED

SHEET: H3

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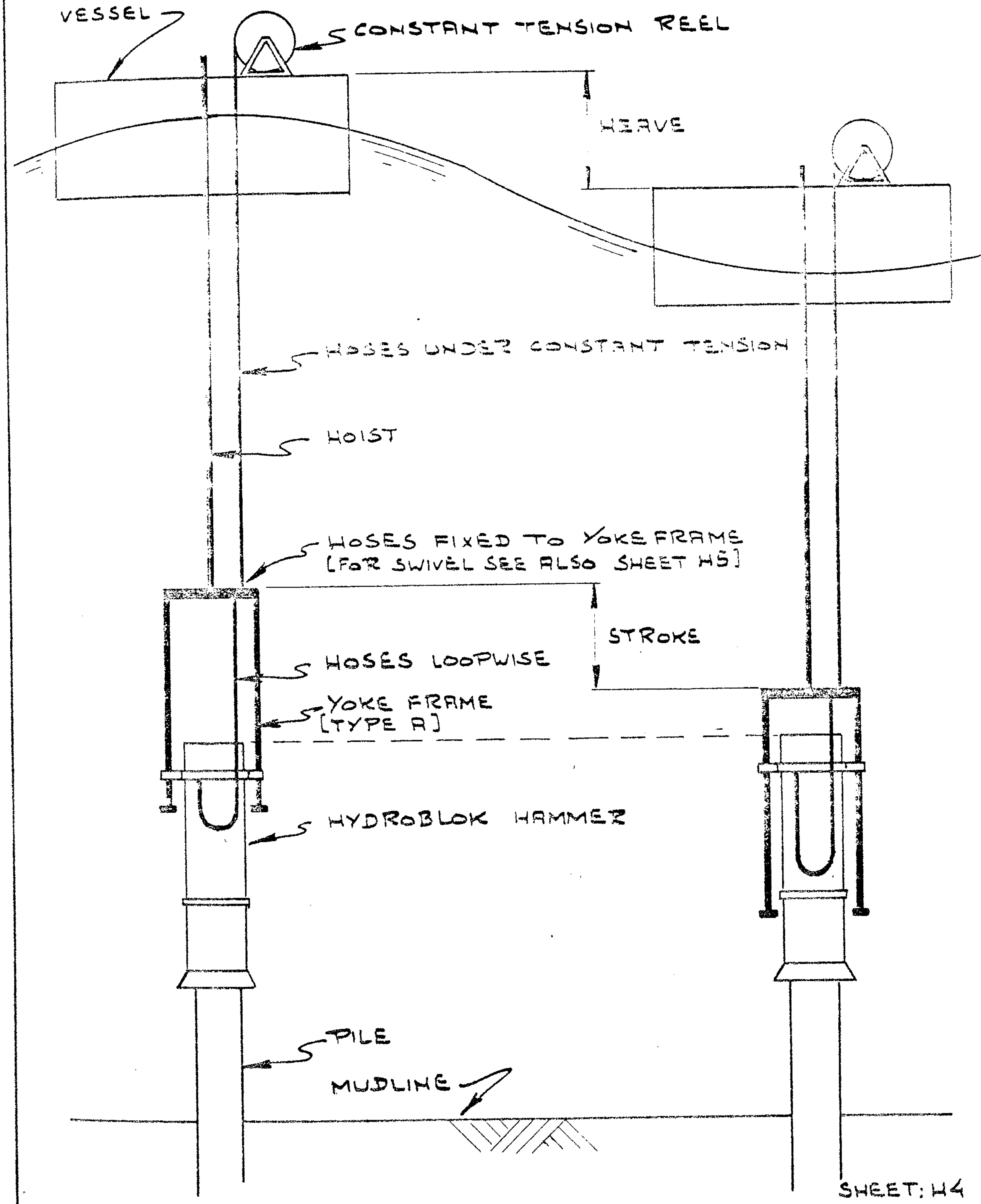
APRIL '79

HOSE HANDLING AND 'YOKEFRAME' FUNCTION COMBINED

[FOR EXPLANATION OF THE 'YOKEFRAME-FUNCTION' SEE SHEET Y1-Y4]



SHEET: H4

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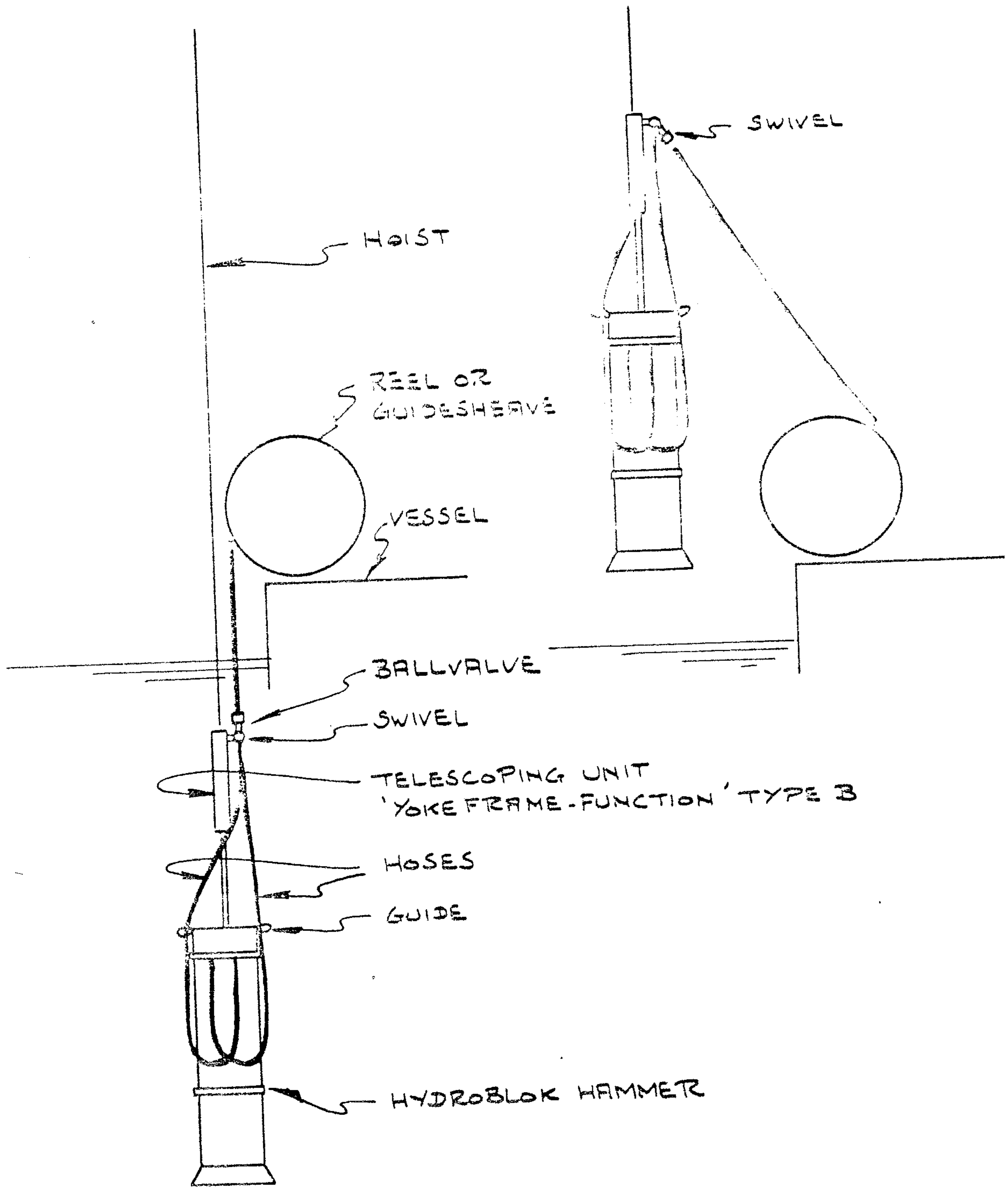
APRIL '79

HOSEHANDLING AND 'YOKEFRAME-FUNCTION' COMBINED



SHEET: H5

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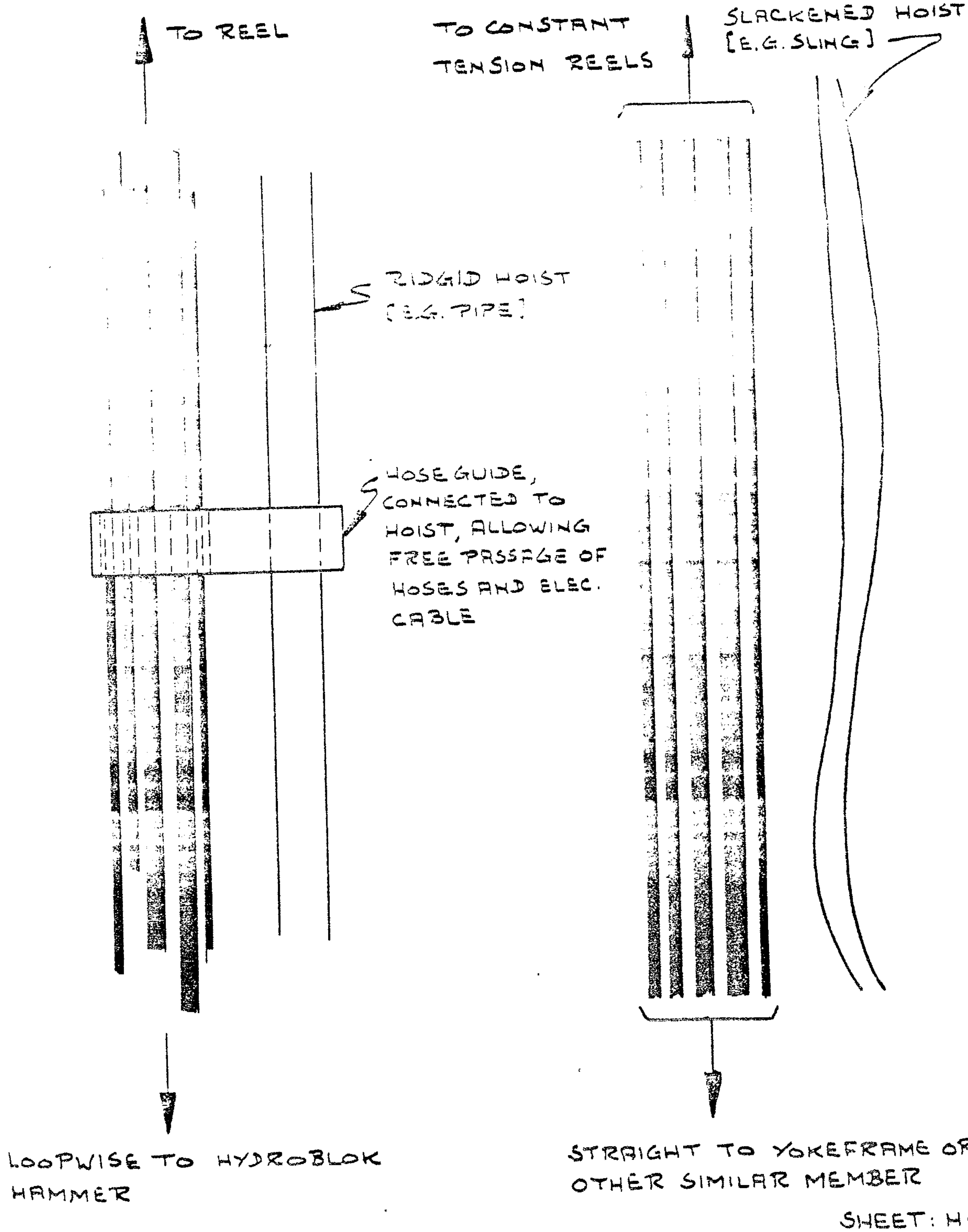
APRIL '79

PROVISIONS TO AVOID HOSE - OR CABLE DAMAGE IN ROUGH WATER.

[TO AVOID THE 'HOSEBUNDLE' TO TANGLE IT HAS TO BE GUIDED OR KEPT UNDER CONSTANT TENSION. DEPENDING ON AMBIENT FORCES A COMBINATION OF BOTH MAY BE NECESSARY. CONSTANT TENSION IS ALSO NECESSARY WHEN IT IS DIFFICULT TO CONTROL THE SIMULTANEOUS PAY.OUT OF THE SEPARATE REELS]



SHEET: H6

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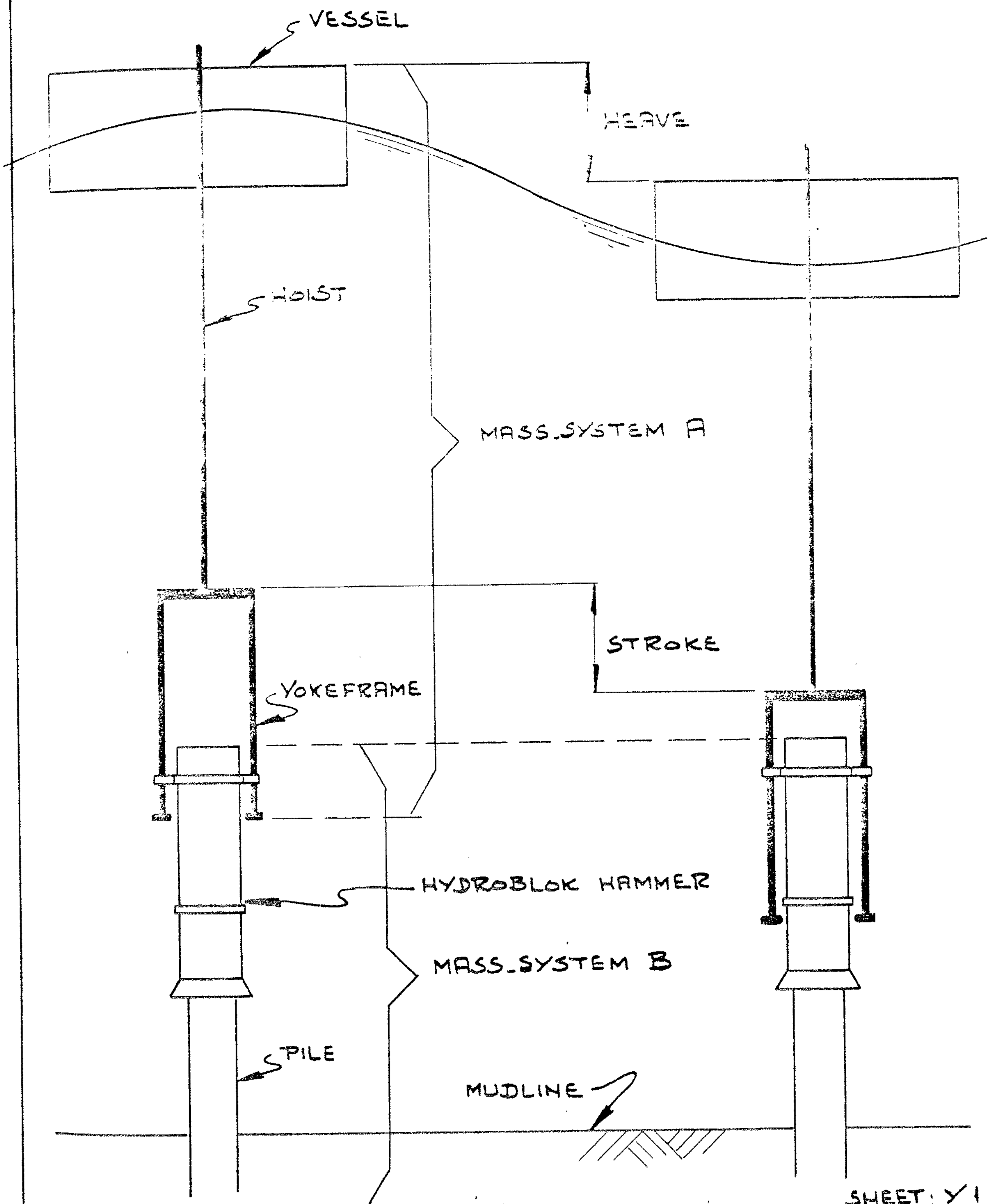
APRIL '79

UNDERWATER DRIVING OFFSHORE BASICALLY REQUIRES THE 'YOKEFRAME-FUNCTION'

TYPE A = REAL YOKEFRAME



SHEET: Y1

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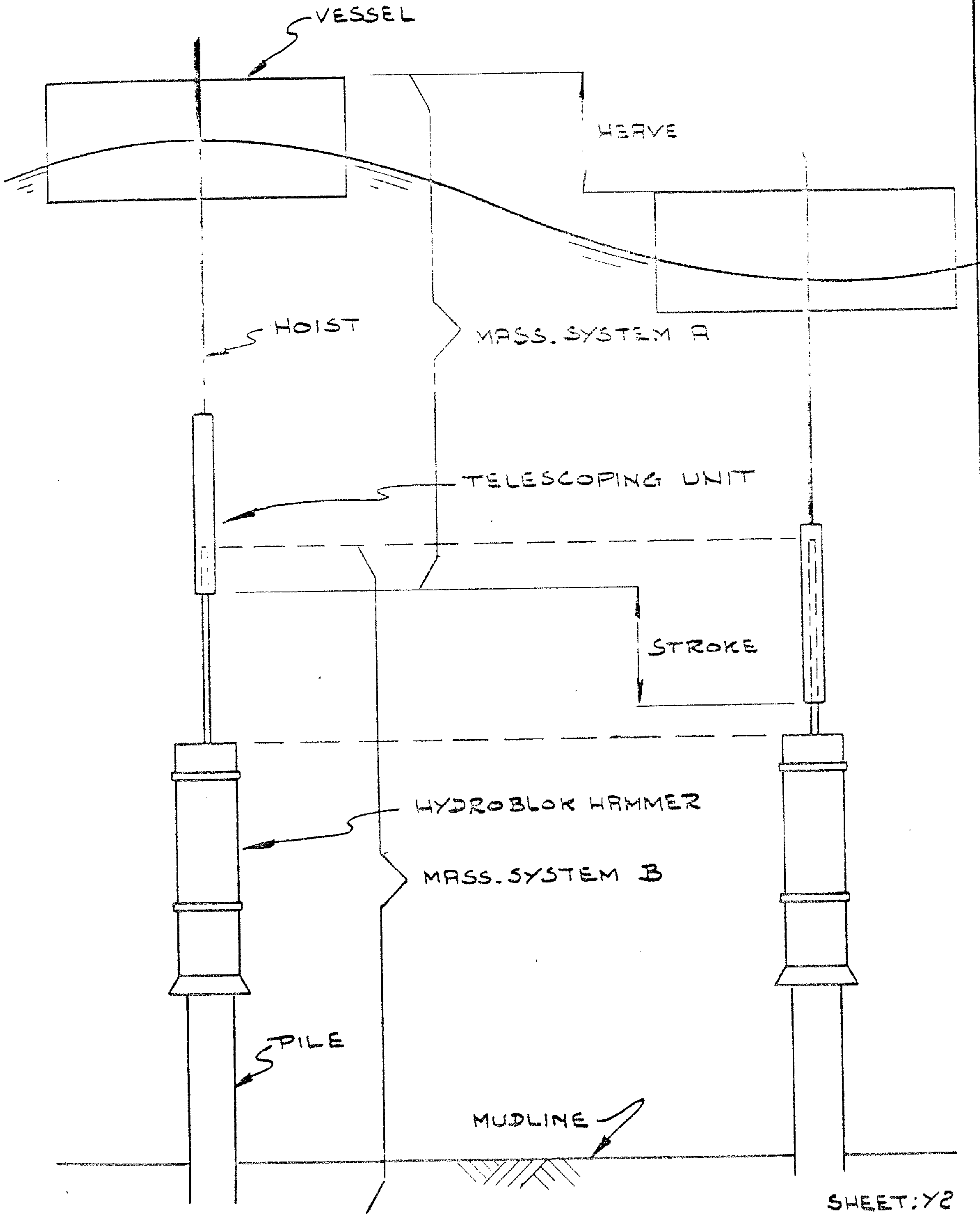
TYPE B: CENTRAL TELESCOPING UNIT



SHEET: Y2

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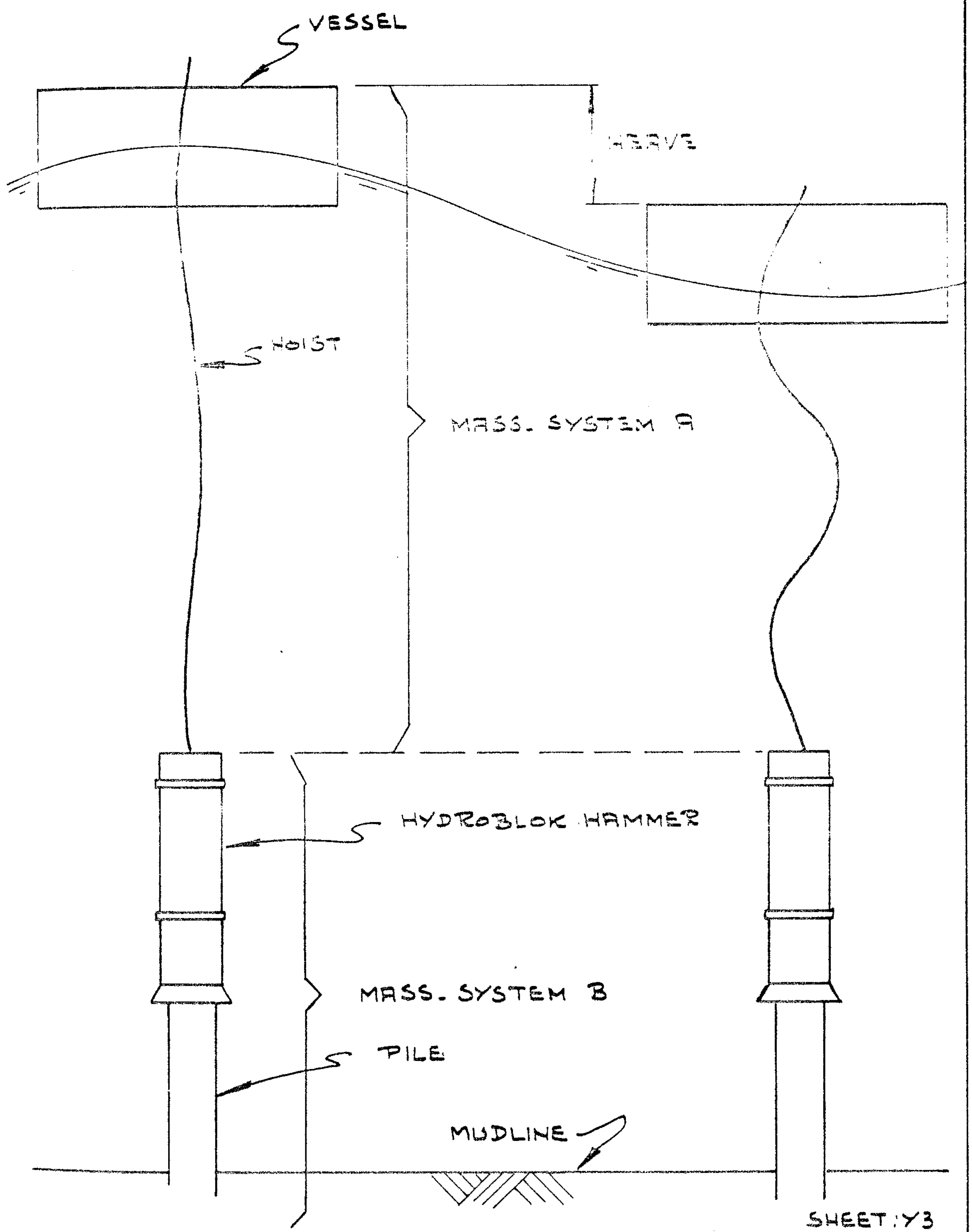
APRIL 79

TYPE C : SLACKED HOIST



SHEET: Y3

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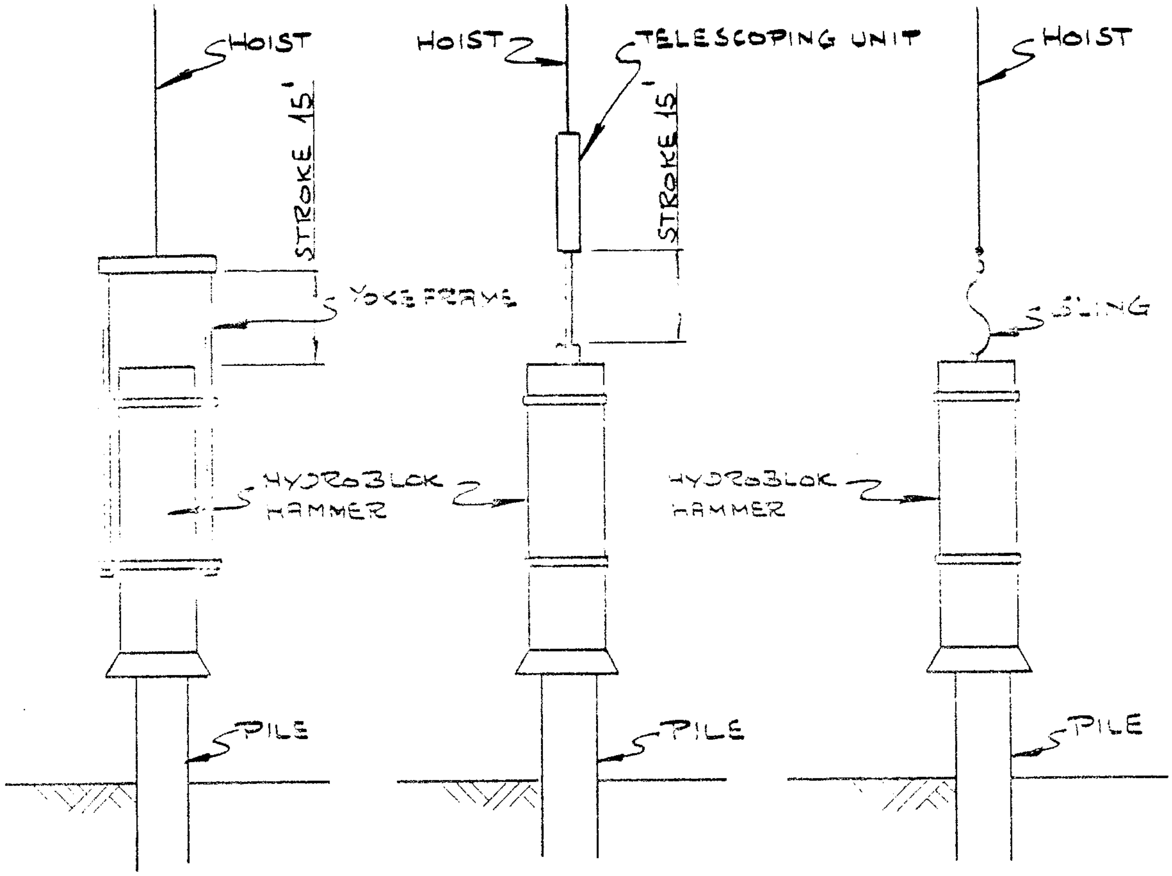
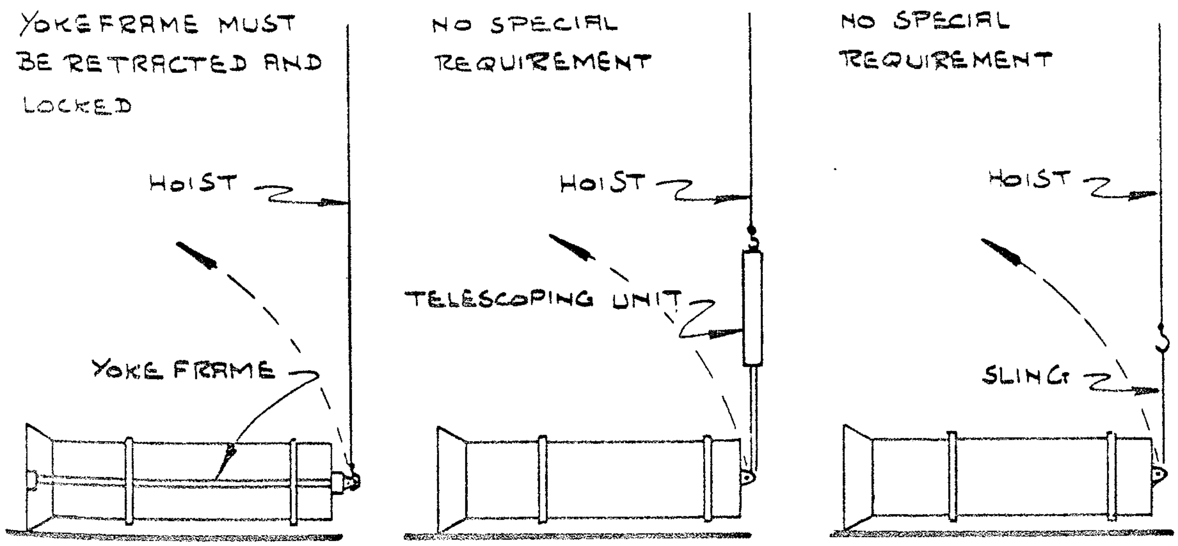
APRIL '79

HANDLING PROPERTIES OF THE 3 TYPES OF 'YOKEFRAME-FUNCTIONS'

TYPE: A | TYPE: B | TYPE: C





FOR HOSE CONNECTIONS SEE SHEET

SHEET: 74

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APRIL 79

WEIGHTS OF HYDROBLOK HAMMER HBM 3000A
INCLUDING 'YOKEFRAME-FUNCTION'

WEIGHT IN AIR [METRIC TON]

TYPE-A:

HAMMER + YOKEFRAME	: 225 TON
BALLAST FOR UNDERWATER USE	: 16 TON
TOTAL	: 241 TON

TYPE-B:

HAMMER + CENTRAL TELESCOPING UNIT	: 194 TON
BALLAST FOR UNDERWATER USE	: 22 TON
TOTAL	: 216 TON

TYPE-C:

HAMMER	: 188 TON
BALLAST FOR UNDERWATER USE	: 25 TON
TOTAL	: 213 TON

NOTE :
BUOYANCY OF THE HAMMER IN WATER 73 TON

TOTAL WEIGHT IN WATER [METRIC TON]

TYPE-A	: 168 TON
TYPE-B	: 143 TON
TYPE-C	: 140 TON

SUBJECT TO MODIFICATION

SHEET: W1

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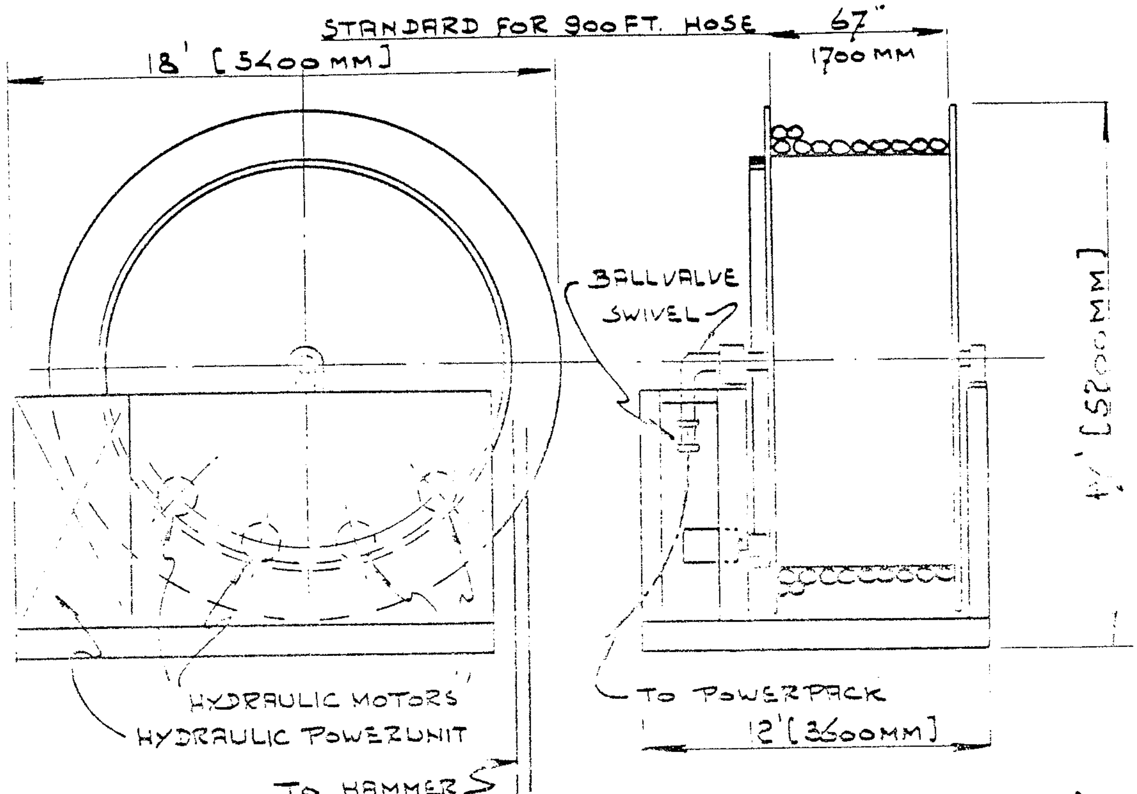
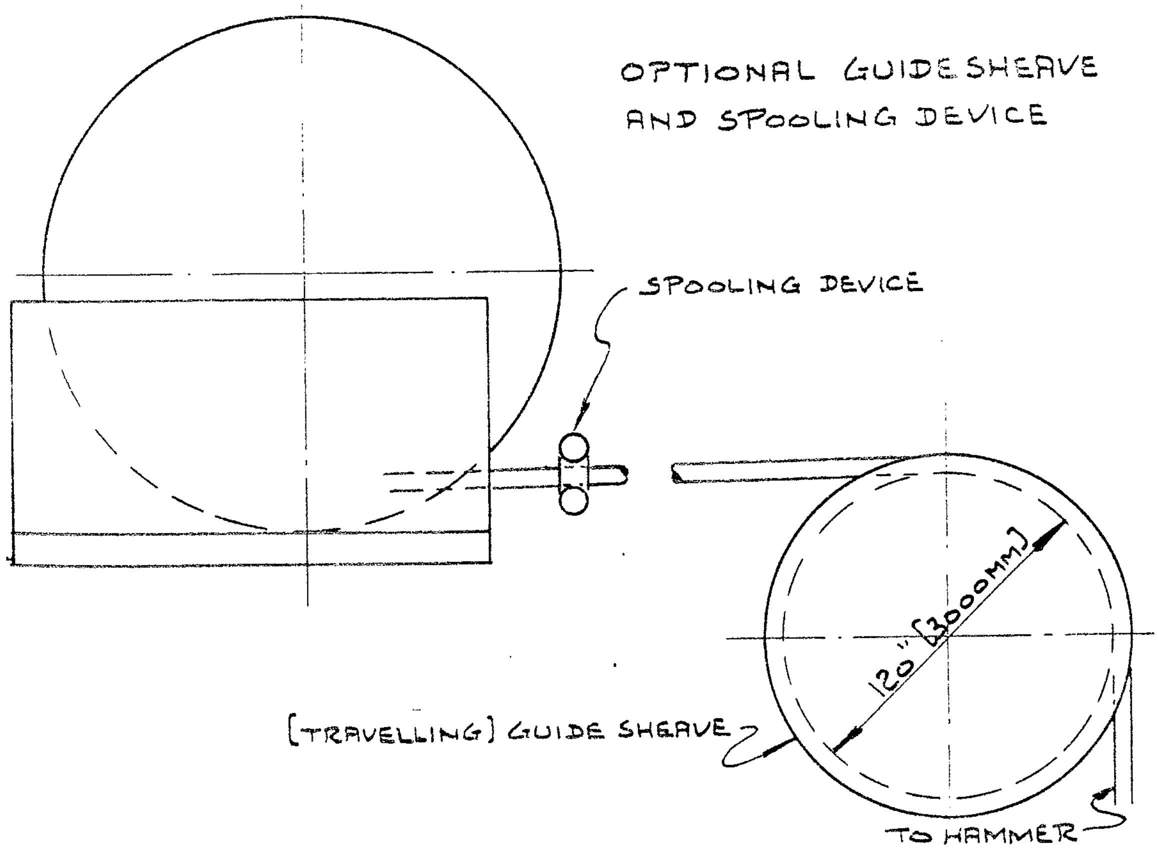
HOSEREEL FOR HOSE 4" I.D. [OIL SUPPLY AND RETURN]



WEIGHT EXCL. HOSE 60000 LBS [27T.]

OPTIONAL GUIDESHEAVE AND SPOOLING DEVICE



SHEET: R1

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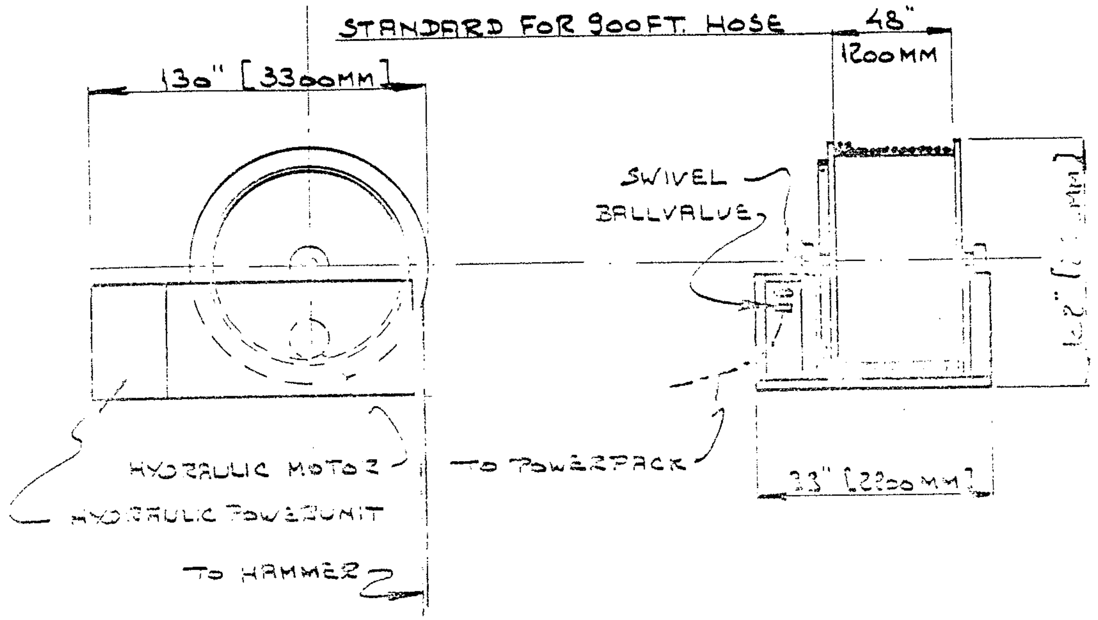
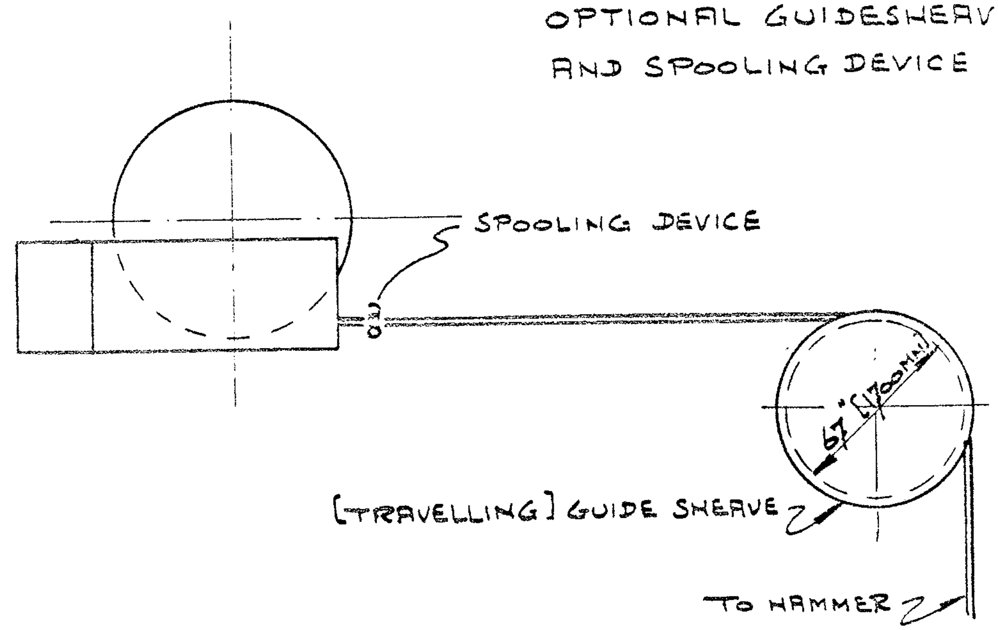
APRIL '79

HOSEREEL FOR HOSE 1 1/4" I.D. [BUFFER AND AIR HOSE, CONTINUOUS LENGTH]



WEIGHT EXCL. HOSE 13000LBS [6T.]

OPTIONAL GUIDESHEAVE AND SPOOLING DEVICE



SHEET: R2

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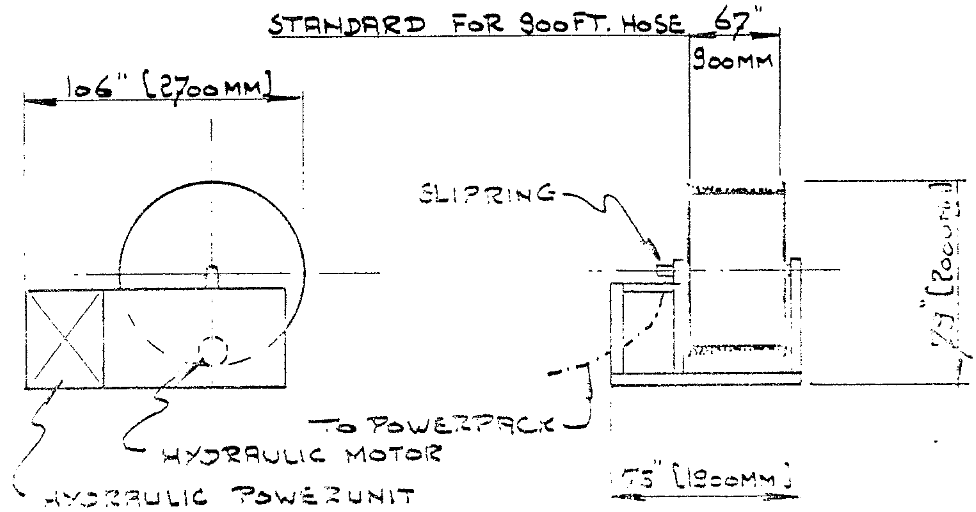
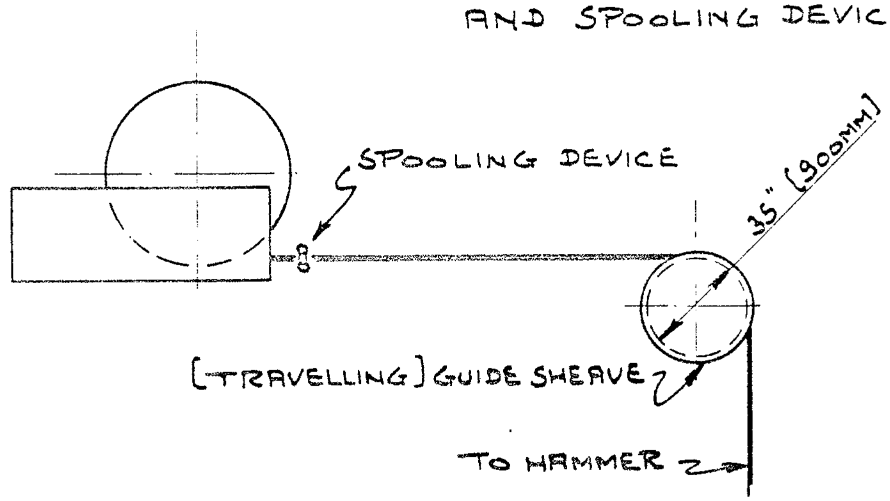
ELECTRIC CABLE REEL



WEIGHT EXCL. CABLE 11000LBS [5T.]

OPTIONAL GUIDESHEAVE AND SPOOLING DEVICE



SHEET: R3

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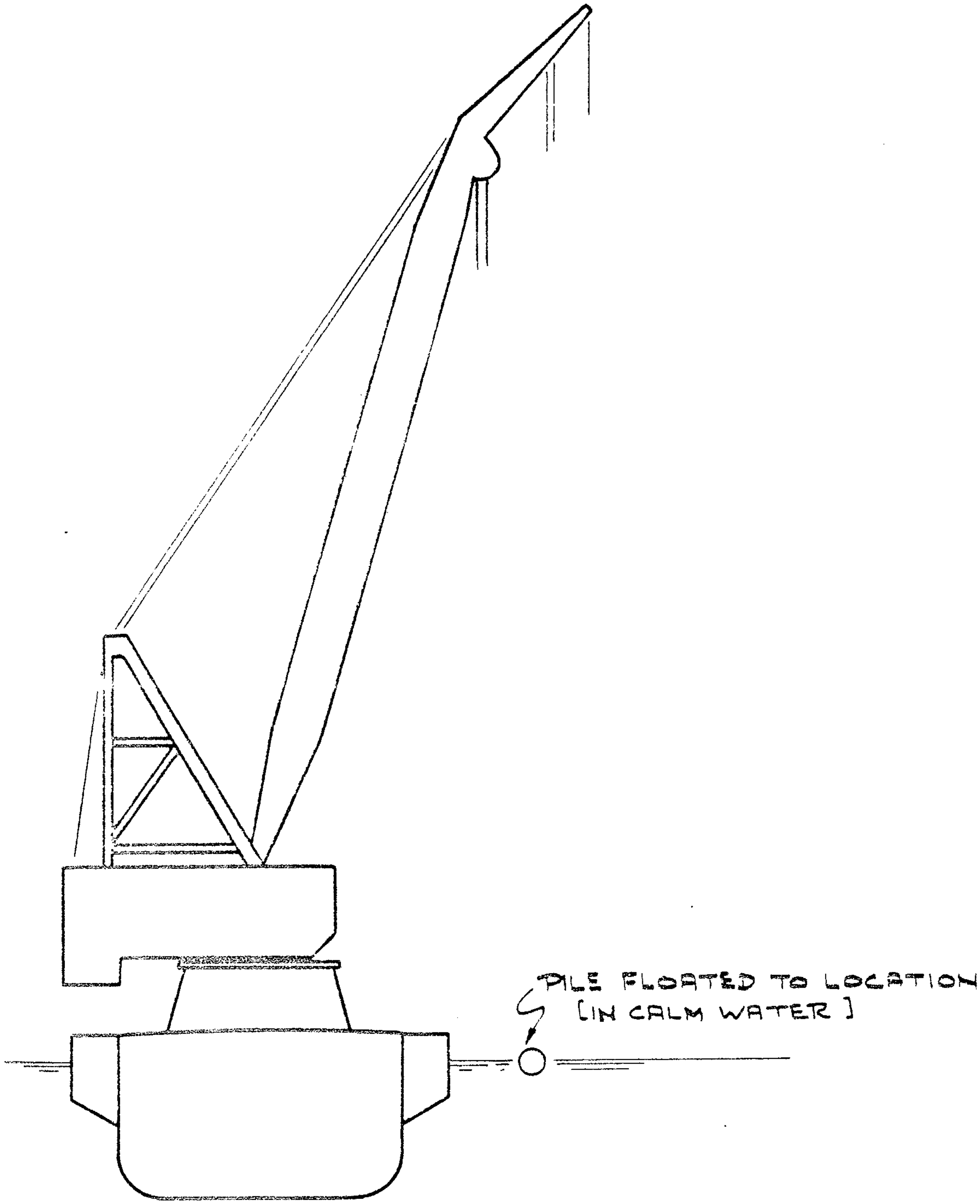
APRIL '79

TRANSPORTATION OF PILES



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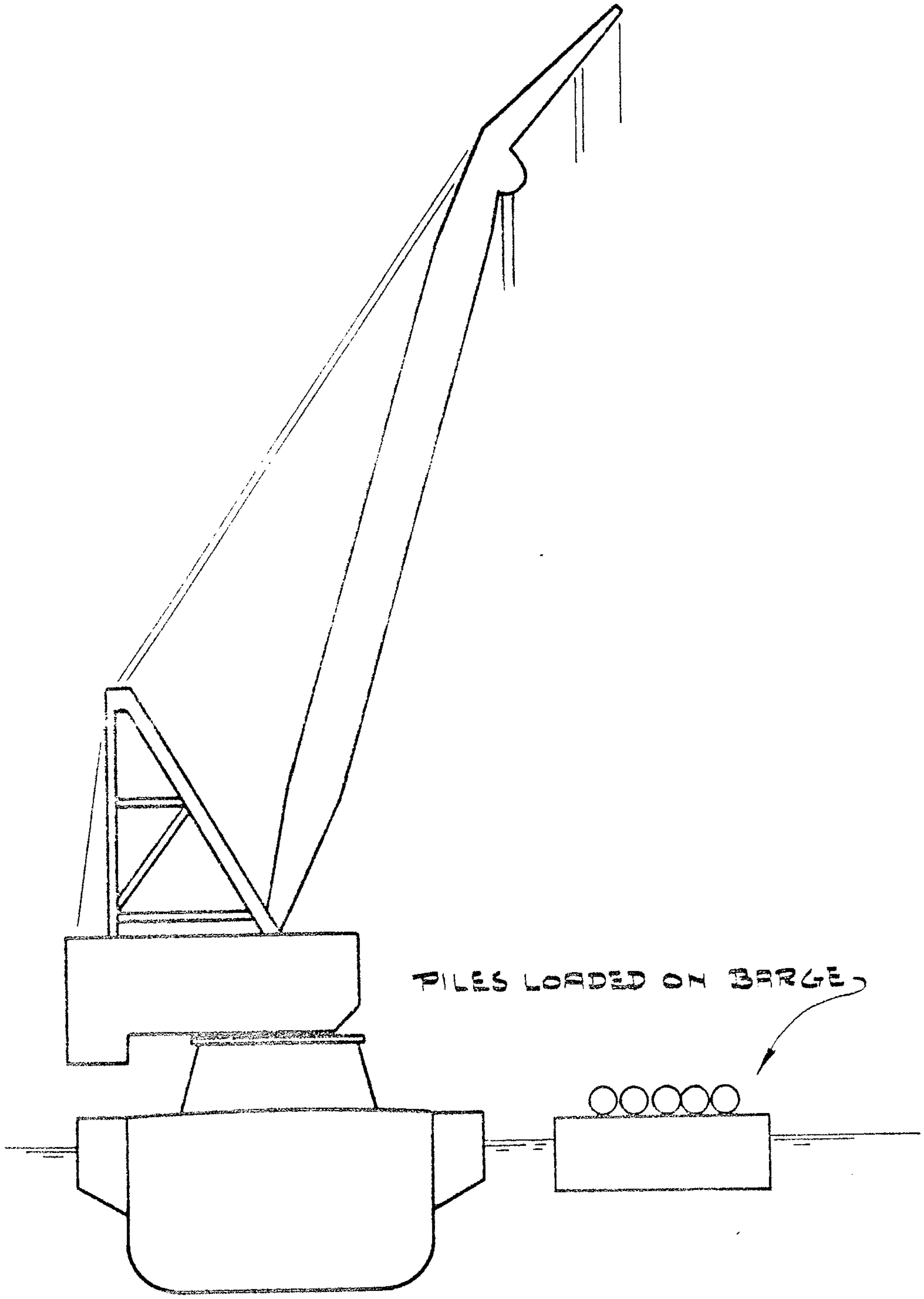
APRIL '79

TRANSPORTATION OF PILES

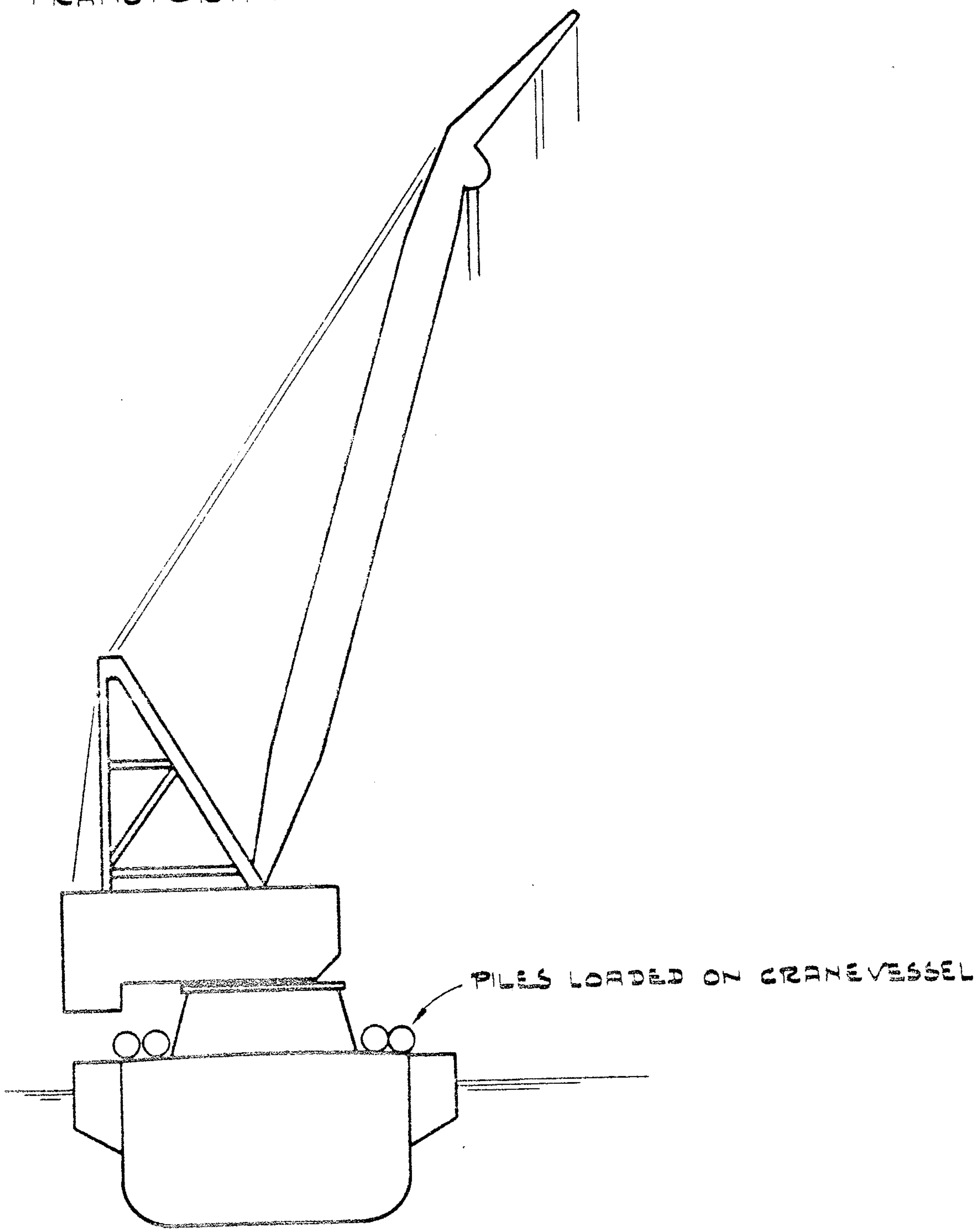


hydroblok

0400.00.131

APRIL '79

TRANSPORTATION OF PILES



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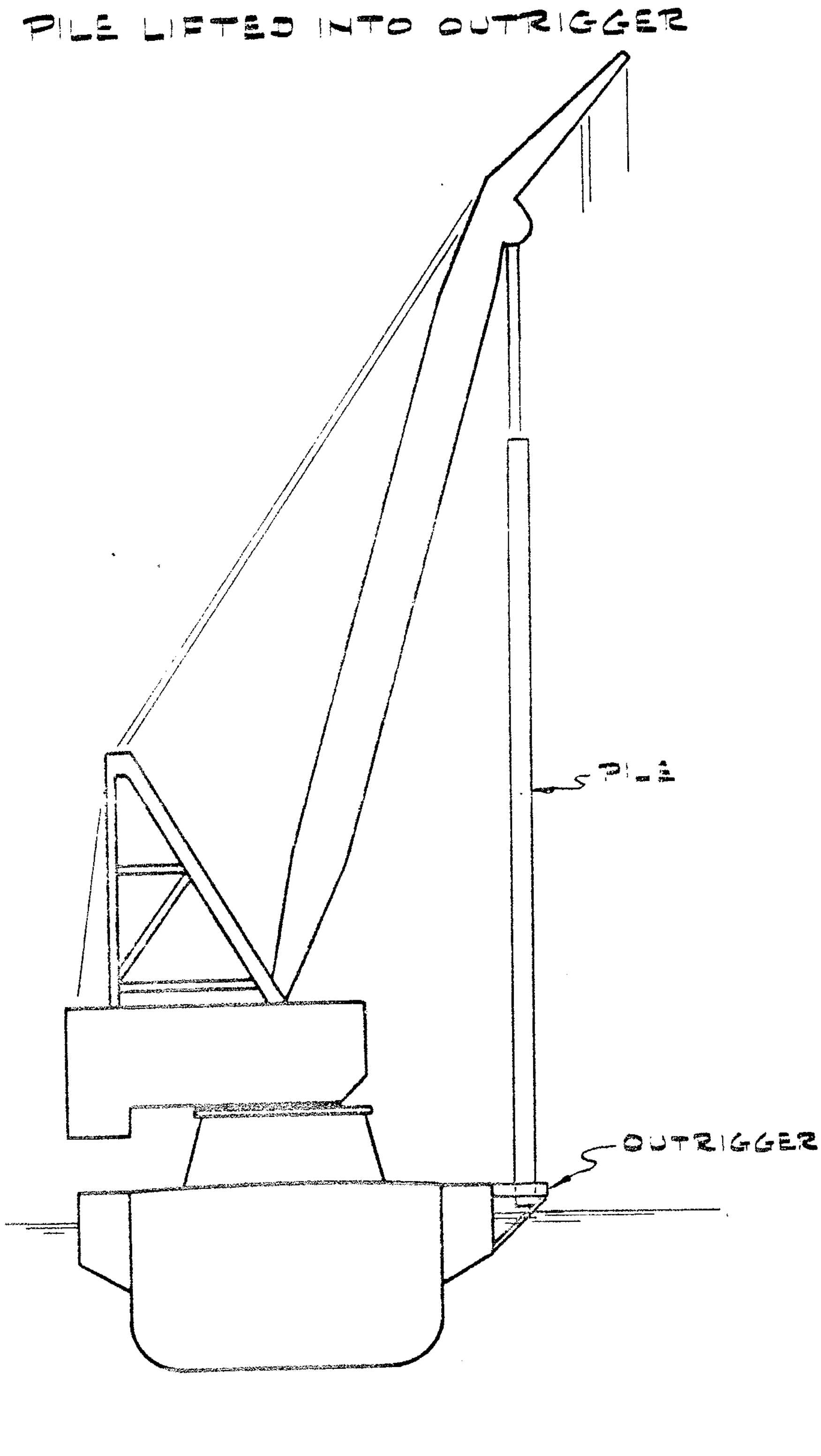
APRIL '79



hydroblok

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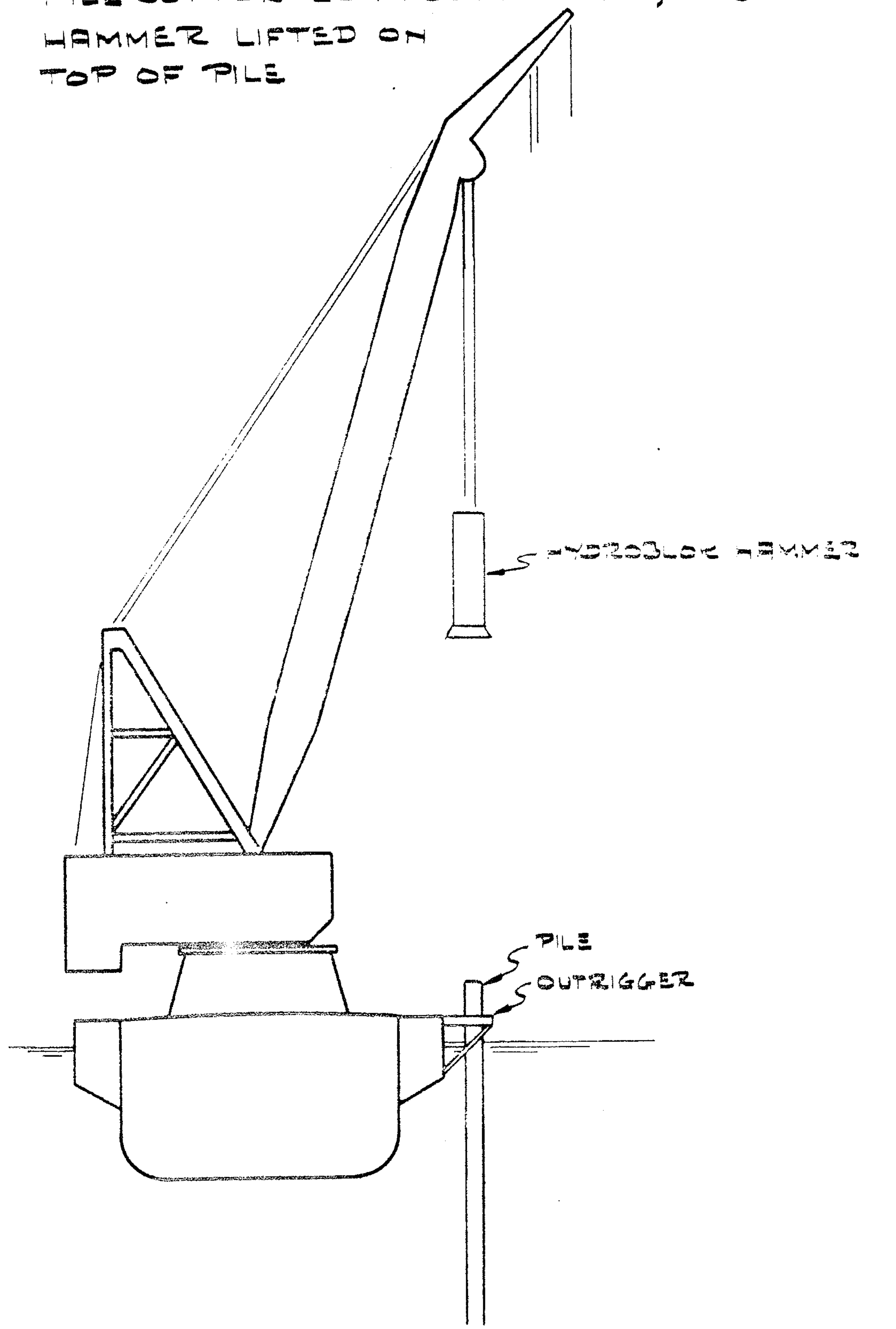
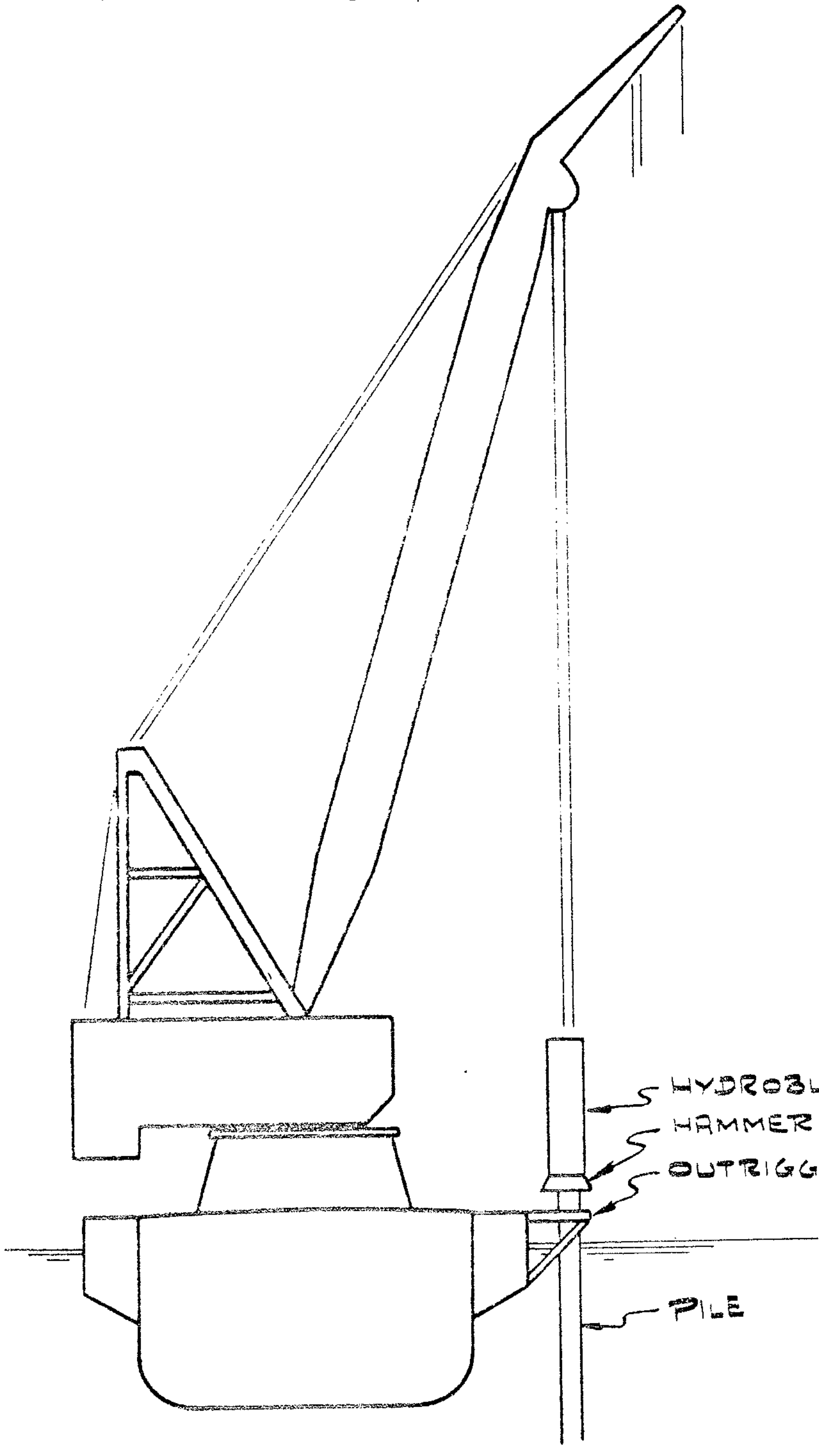
APRIL '79

PILE SUPPORTED IN OUTRIGGER, HYDROBLOK HAMMER LIFTED ON TOP OF PILE



hydroblok	0400.00.134
	APRIL '79

HYDROBLOK HAMMER CONNECTED TO PILE



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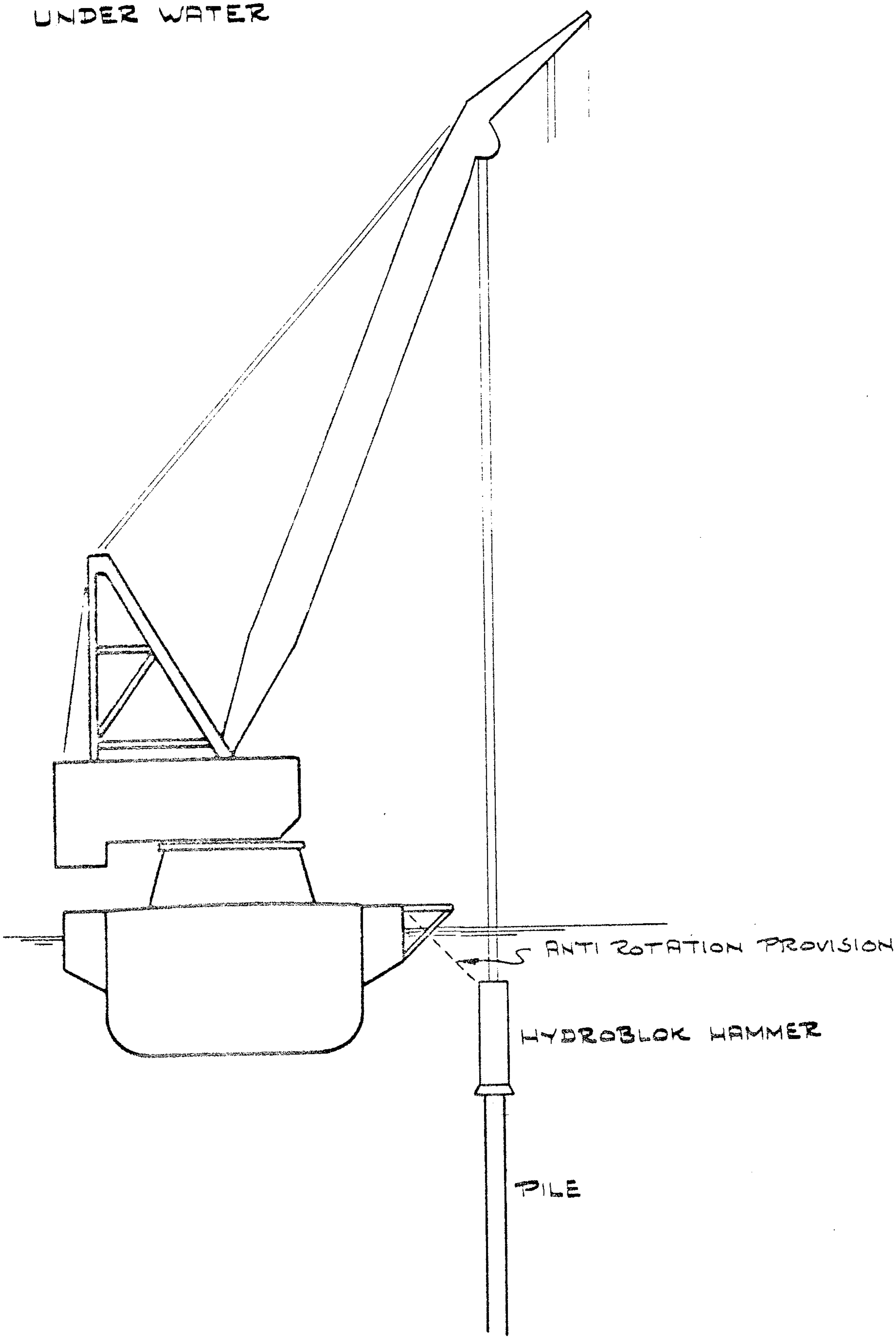
APRIL '79

HYDROBLOK HAMMER AND PILE LOWERED JOINTLY UNDER WATER



hydroblok

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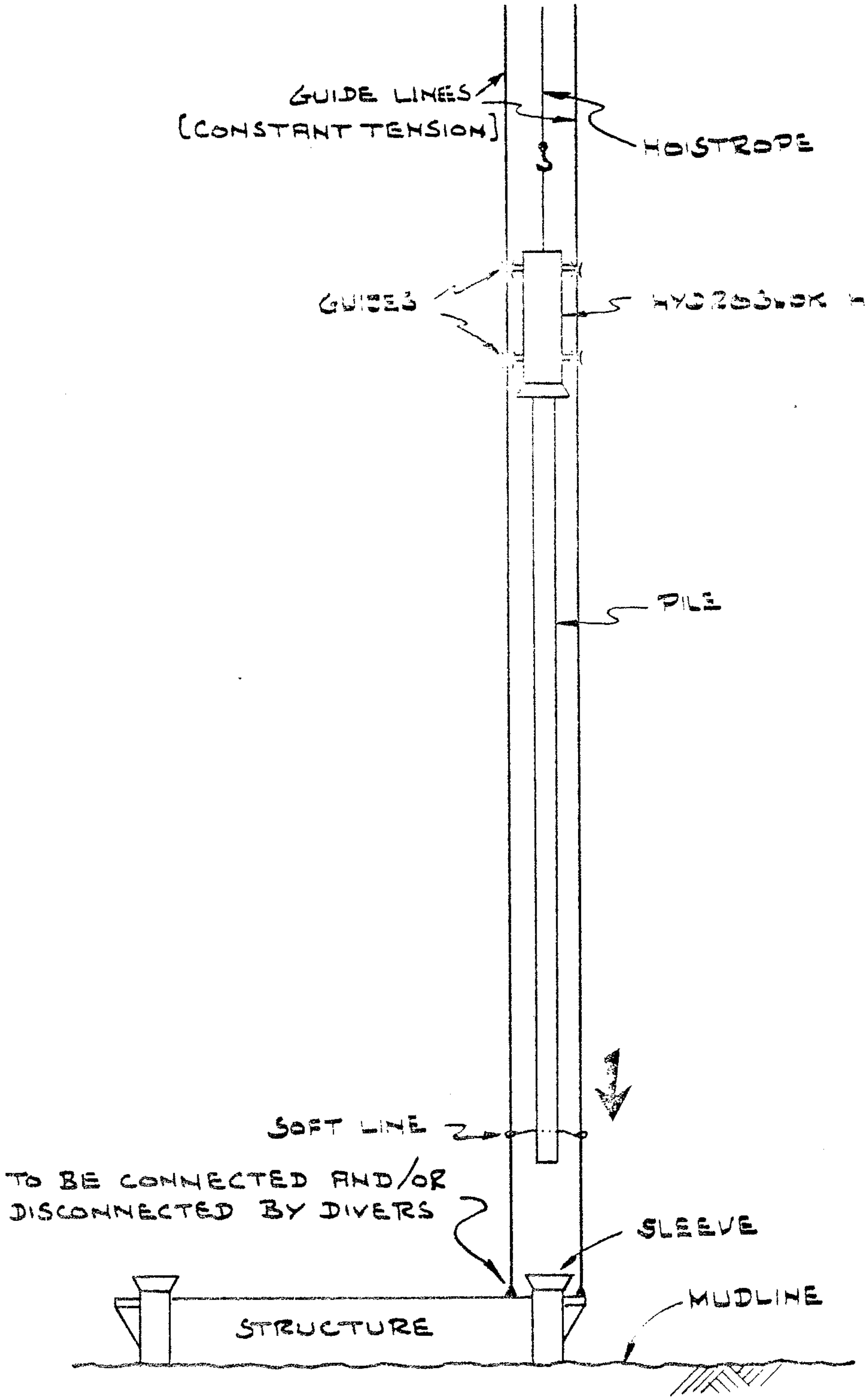
APRIL '79

STABBING SYSTEM WITH GUIDELINES

PILE AND HYDROBLOK HAMMER JOINTLY LOWERED



THIS SYSTEM DOES NOT REQUIRE AN ACCURATE POSITIONING SYSTEM OF THE VESSEL

NOTE: HOSE HANDLING NOT INDICATED

hydroblok

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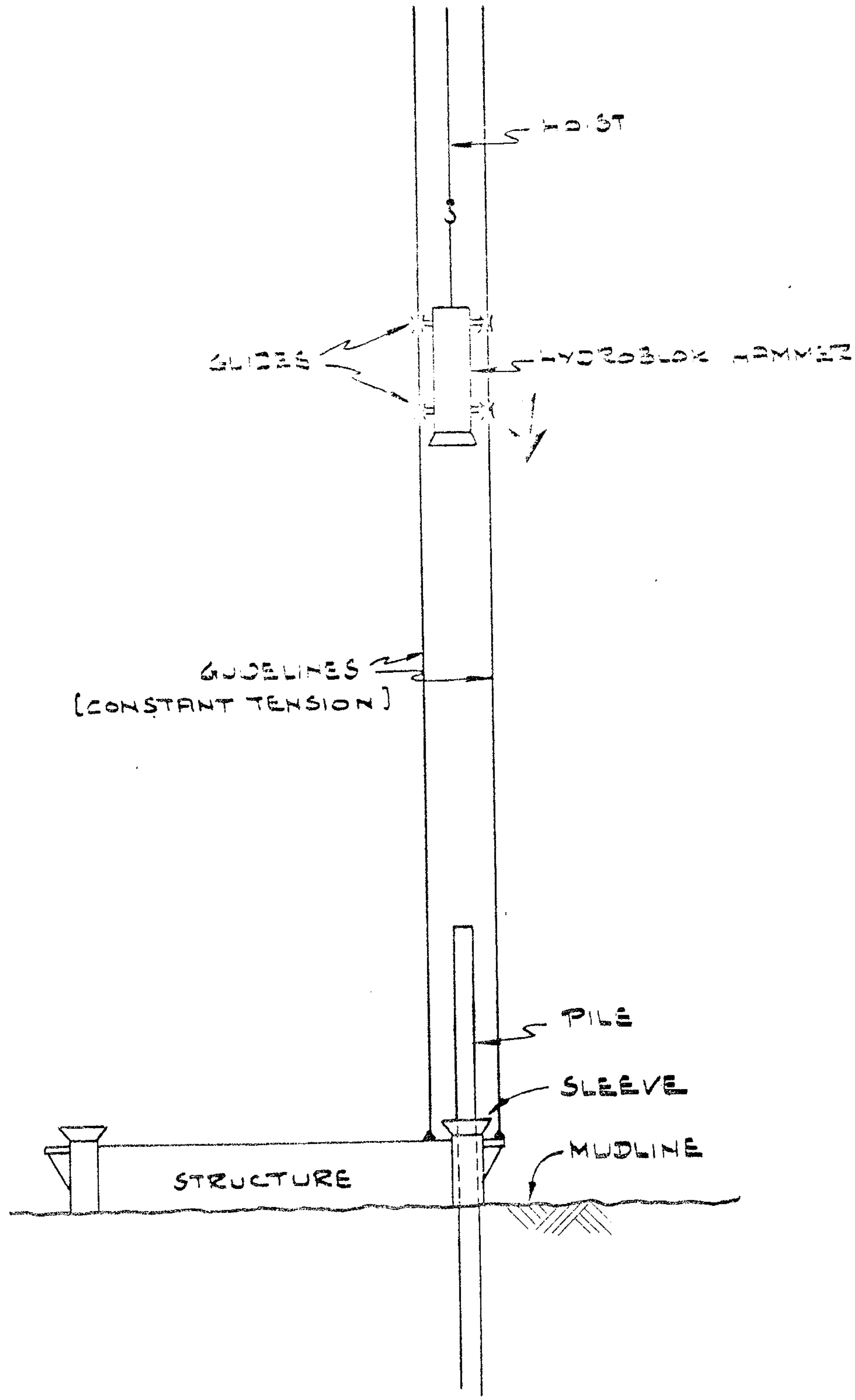
APRIL '79

RELANDING OF HYDROBLOK HAMMER



hydroblok

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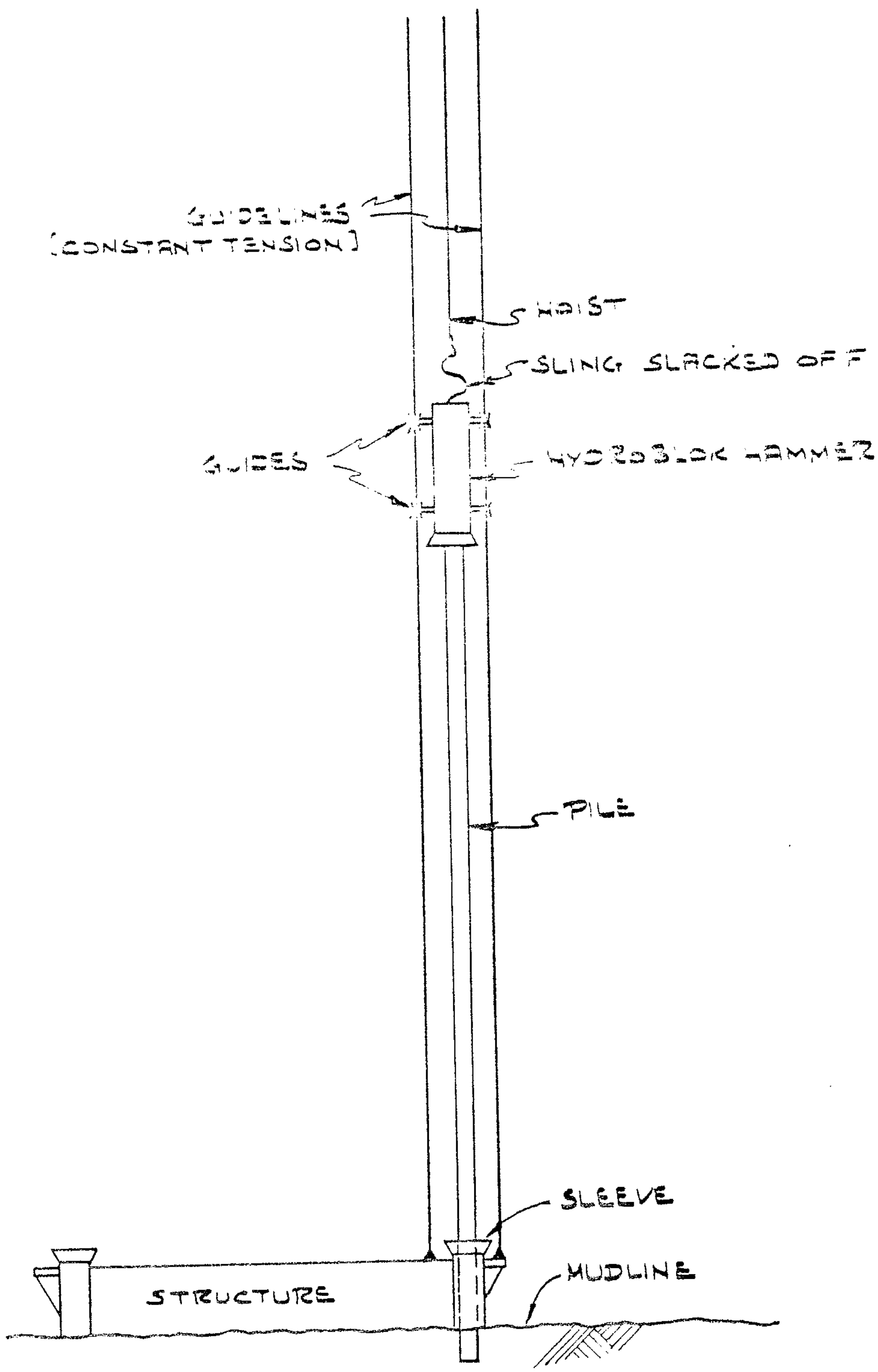
APRIL '79

SITUATION DURING DRIVING



hydroblok

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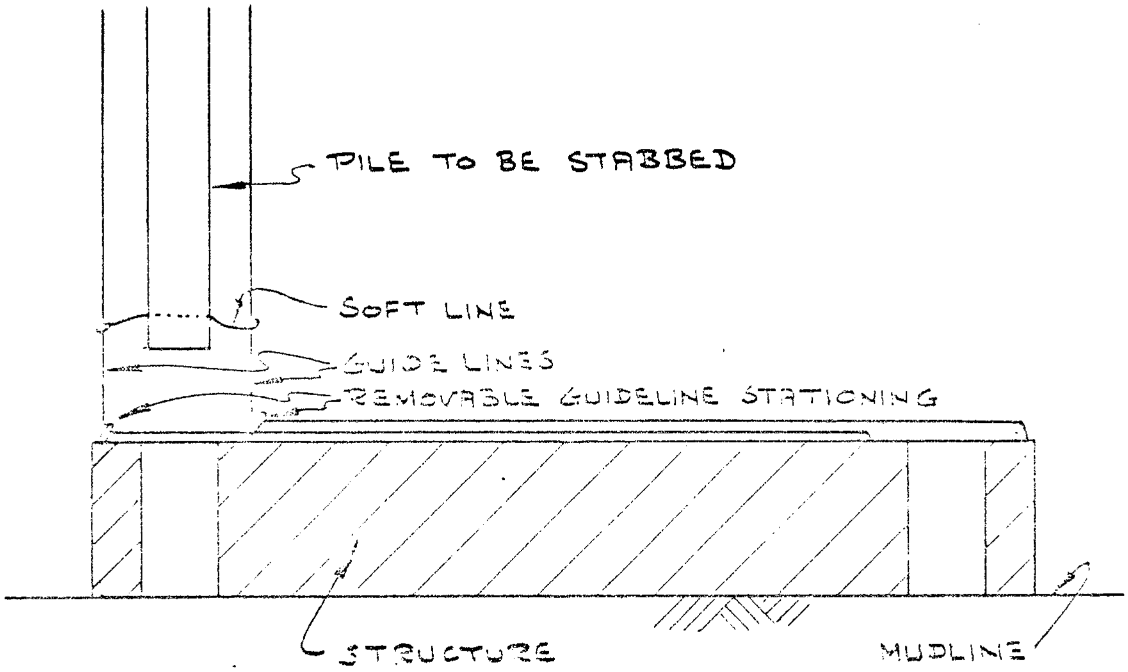
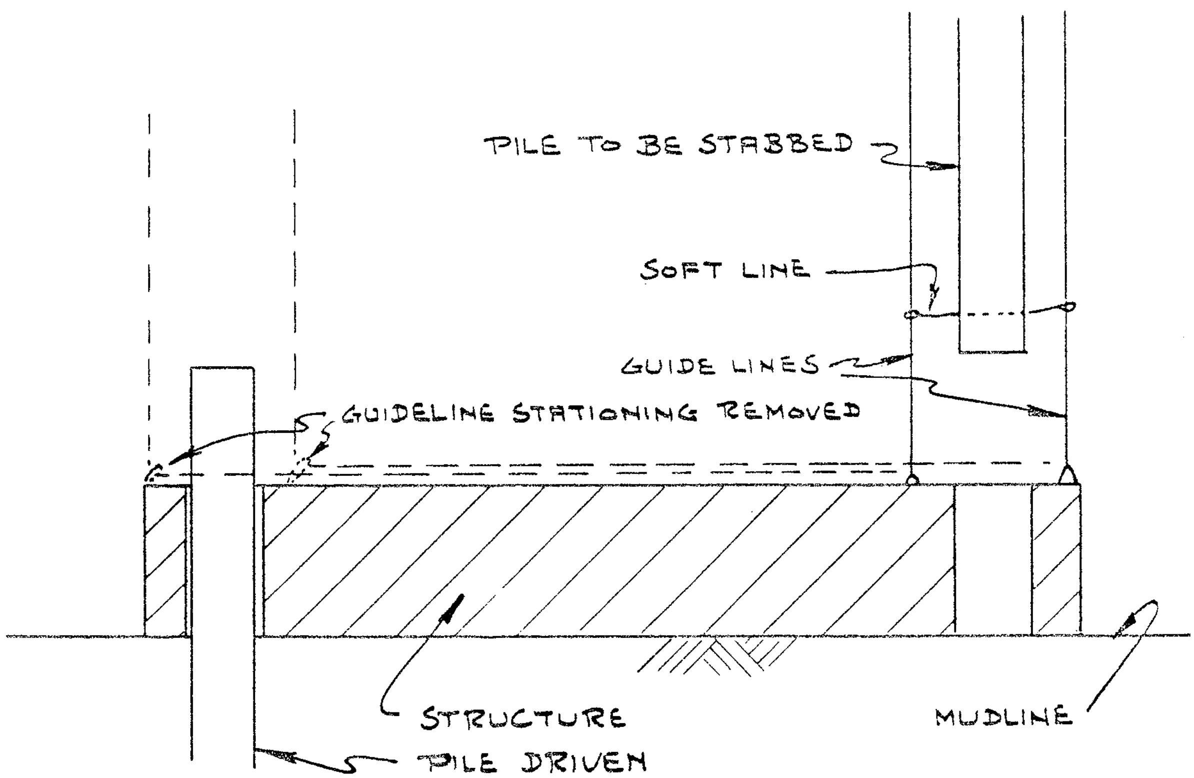
APRIL 79

GUIDELINE REPLACEMENT SYSTEM





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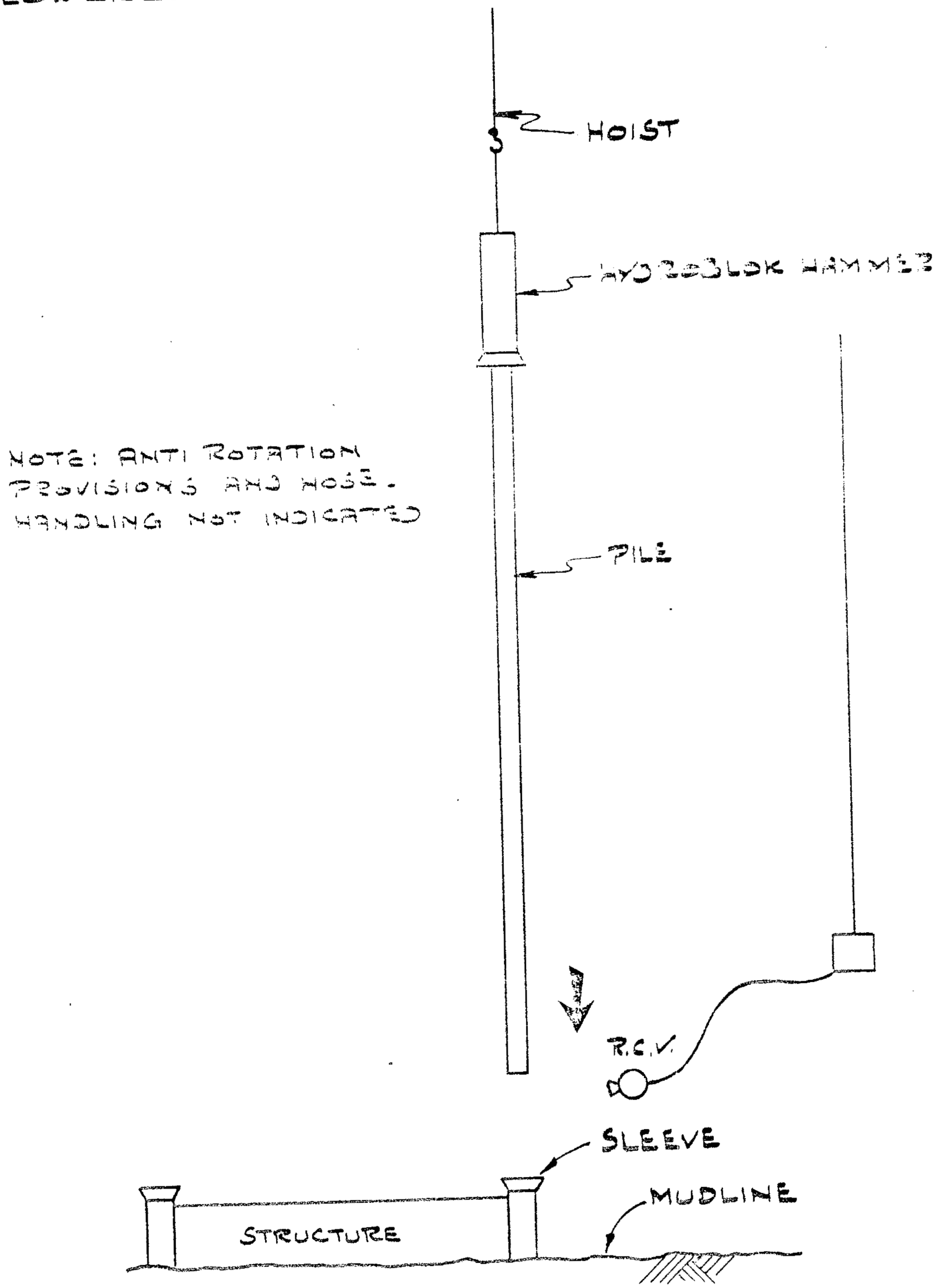
APRIL '79

STABBING WITHOUT GUIDELINES

PILE AND HYDROBLOK HAMMER JOINTLY LOWERED



THIS SYSTEM CAN BE USED WHEN THE VESSEL AND/OR HOIST HAS A GOOD MANOEUVRABILITY.

THE TV-CAMERA WATCHES THE MOVEMENT OF THE PILETIP IN RESPECT OF THE STRUCTURE

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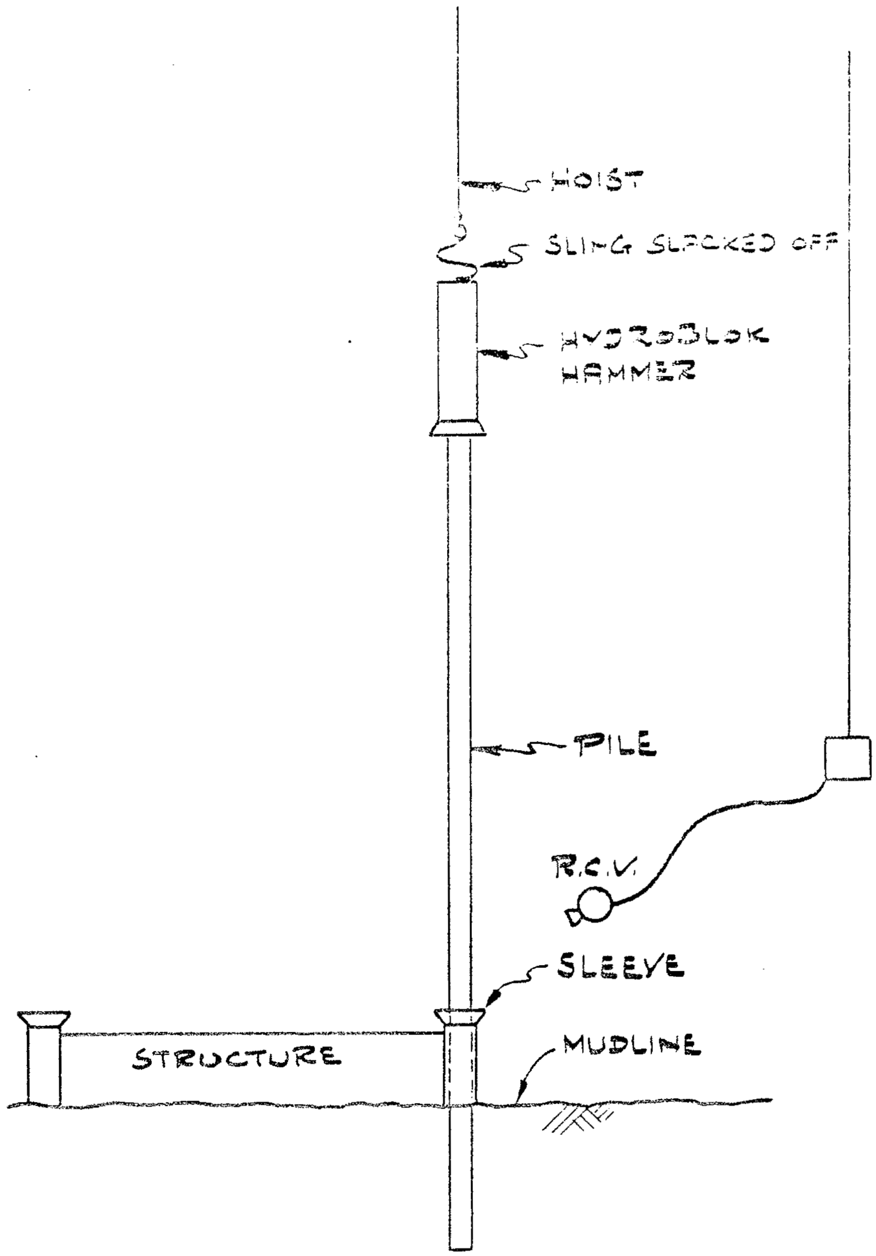
APRIL '79

SITUATION DURING DRIVING



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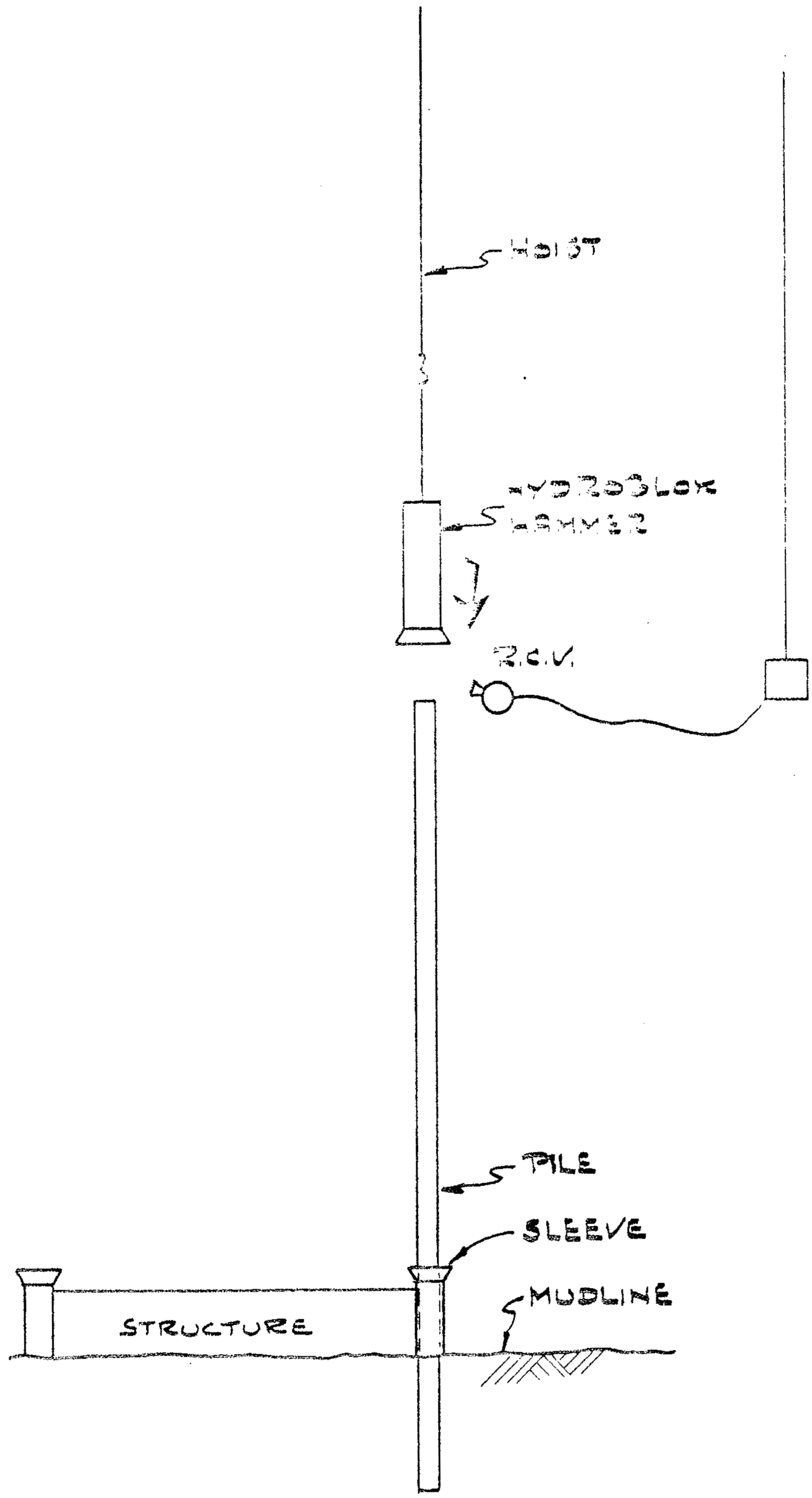
APRIL '79

RELANDING OF HYDROBLOK HAMMER



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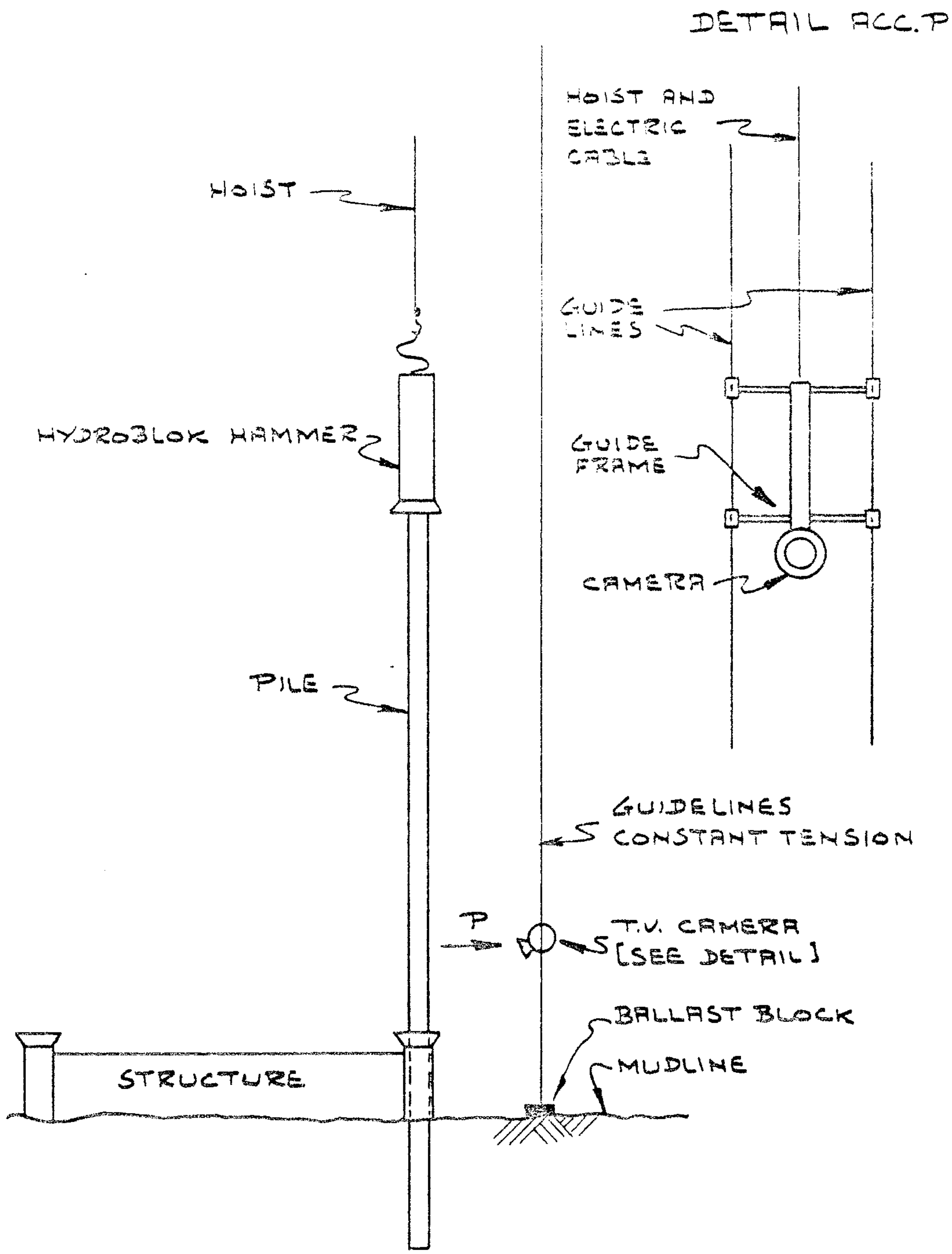
APRIL '79

T.V. CAMERA SYSTEM RUNNING ALONG GUIDELINES



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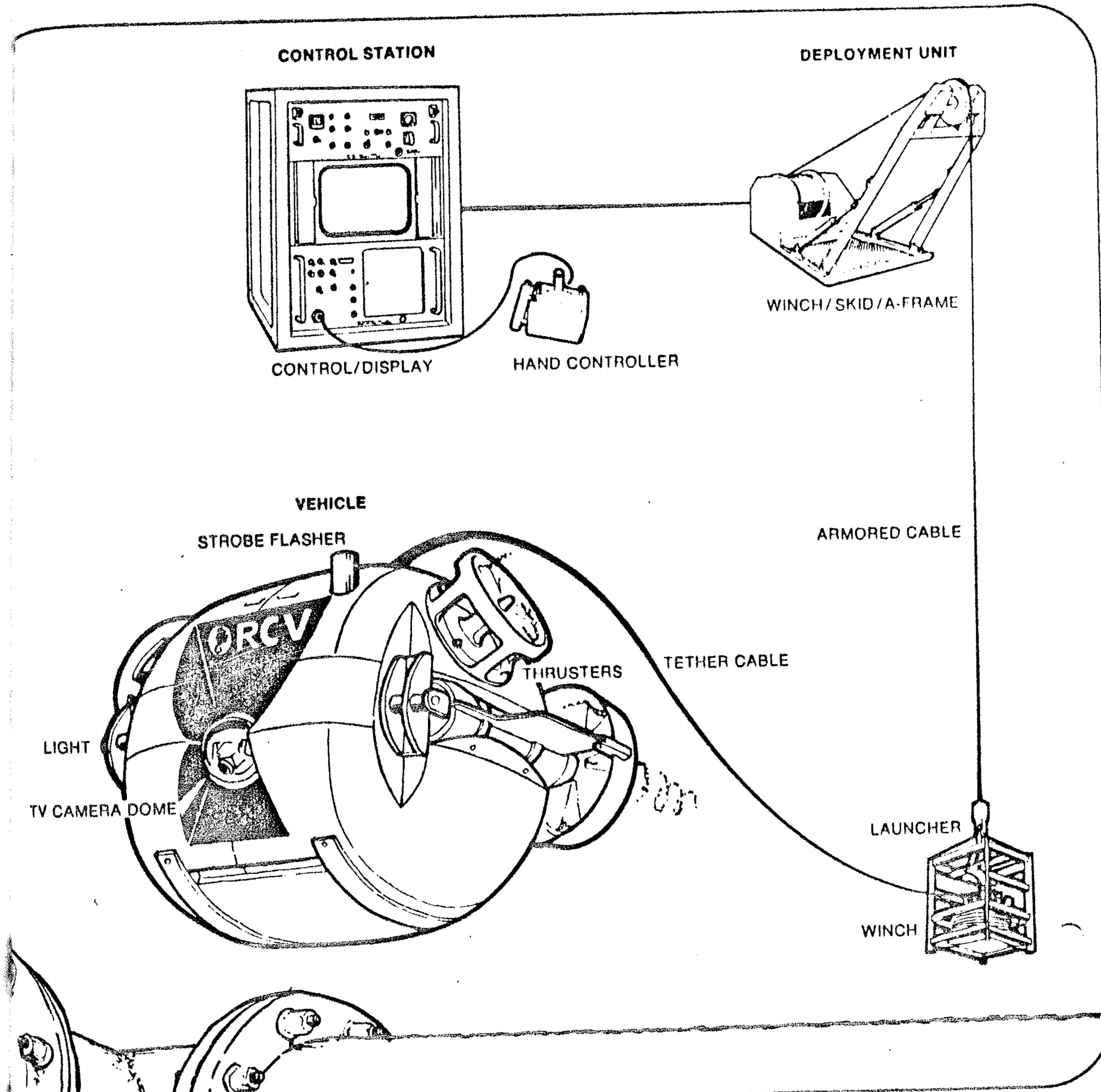
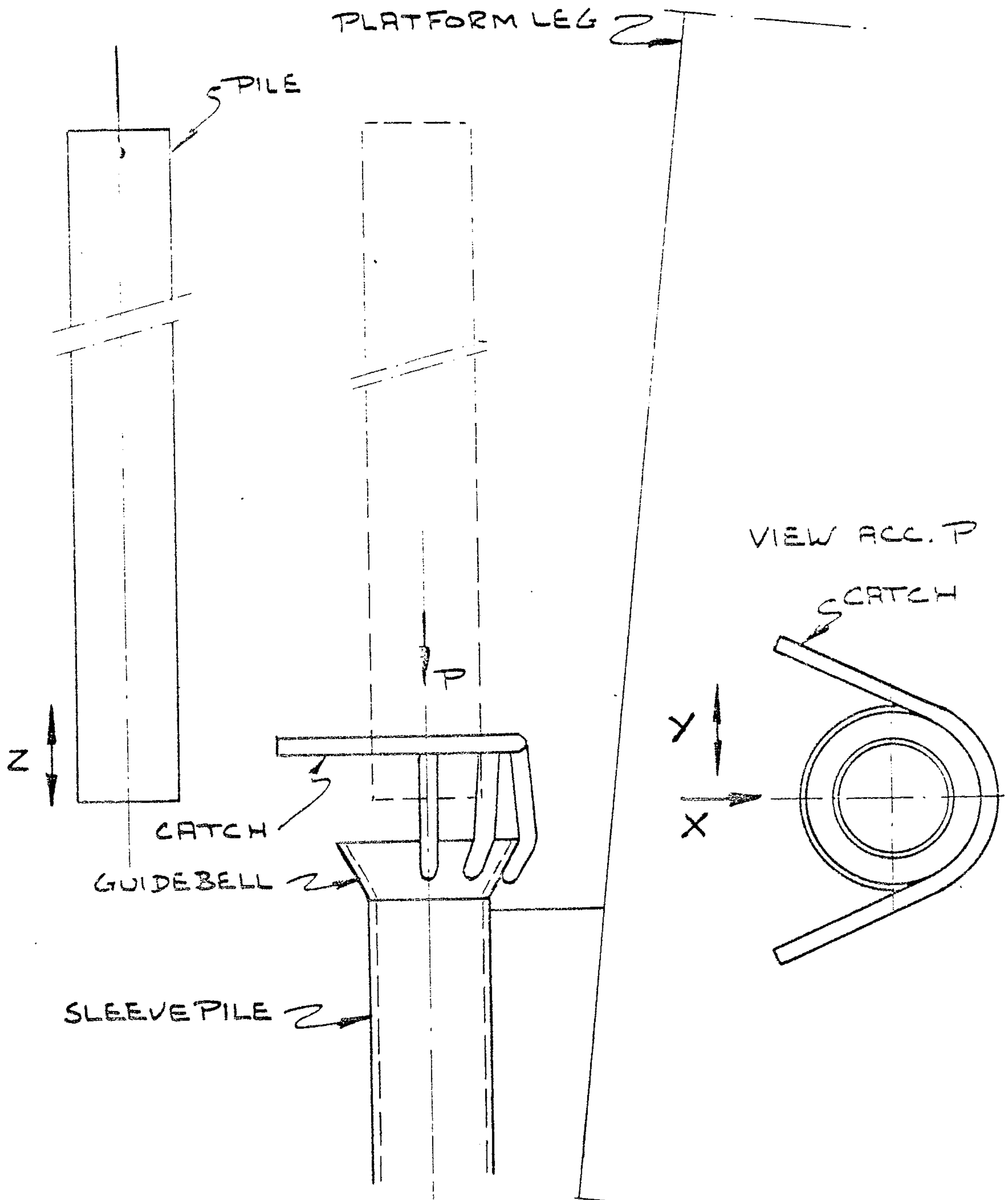


RCV-225 A Production, Field Proven Remote Controlled Vehicle System

FEATURING

- Low light level, long distance, TV viewing
- Precise RCV control for close up inspection
- Fast, safe, system set-up and deployment

OPEN CATCH TO AVOID DAMAGE TO A STRUCTURE WHEN STABBING WITHOUT GUIDELINES



PILE LOWERED EXCENTRICALLY IN RESPECT OF ℄ SLEEVE PILE. BY MANOEUVRING IN X-Y AND Z DIRECTION THE PILE IS STABBED INTO THE GUIDEBELL

hydroblok

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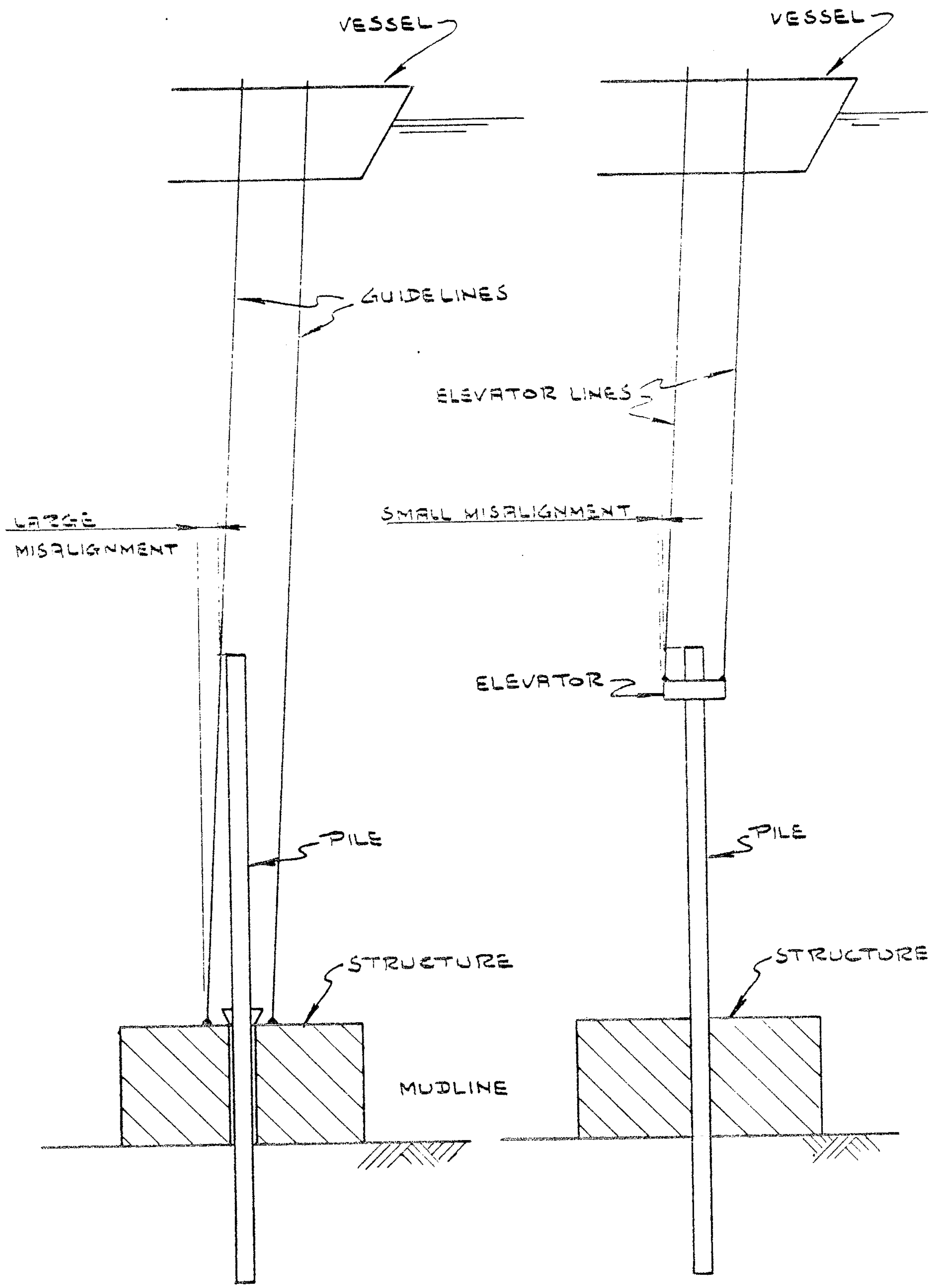
APRIL '79

ELEVATOR SYSTEM, DESIGN PHILOSOPHY



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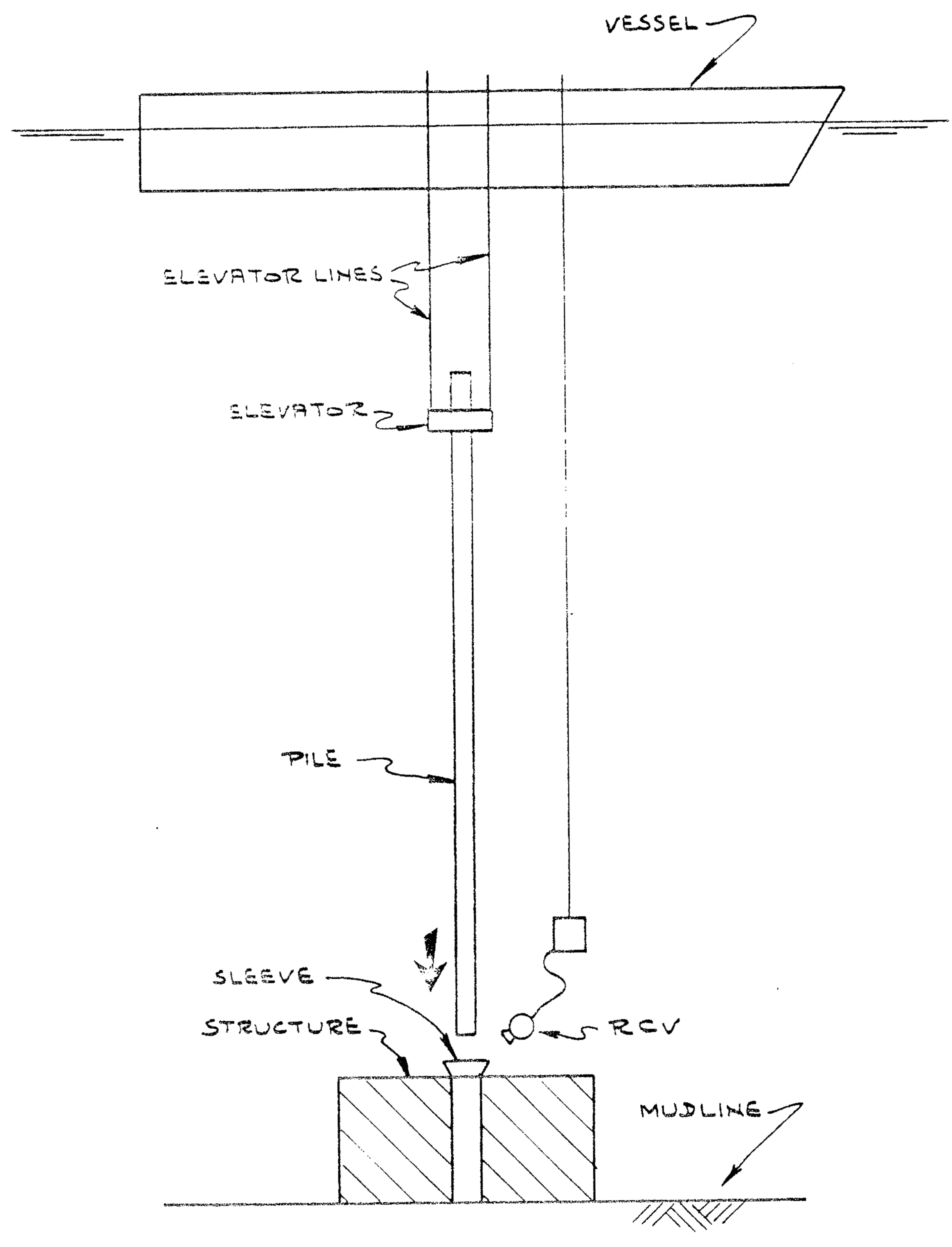
APRIL '79

PILE, HANGING FROM ELEVATOR, STABBED INTO A STRUCTURE



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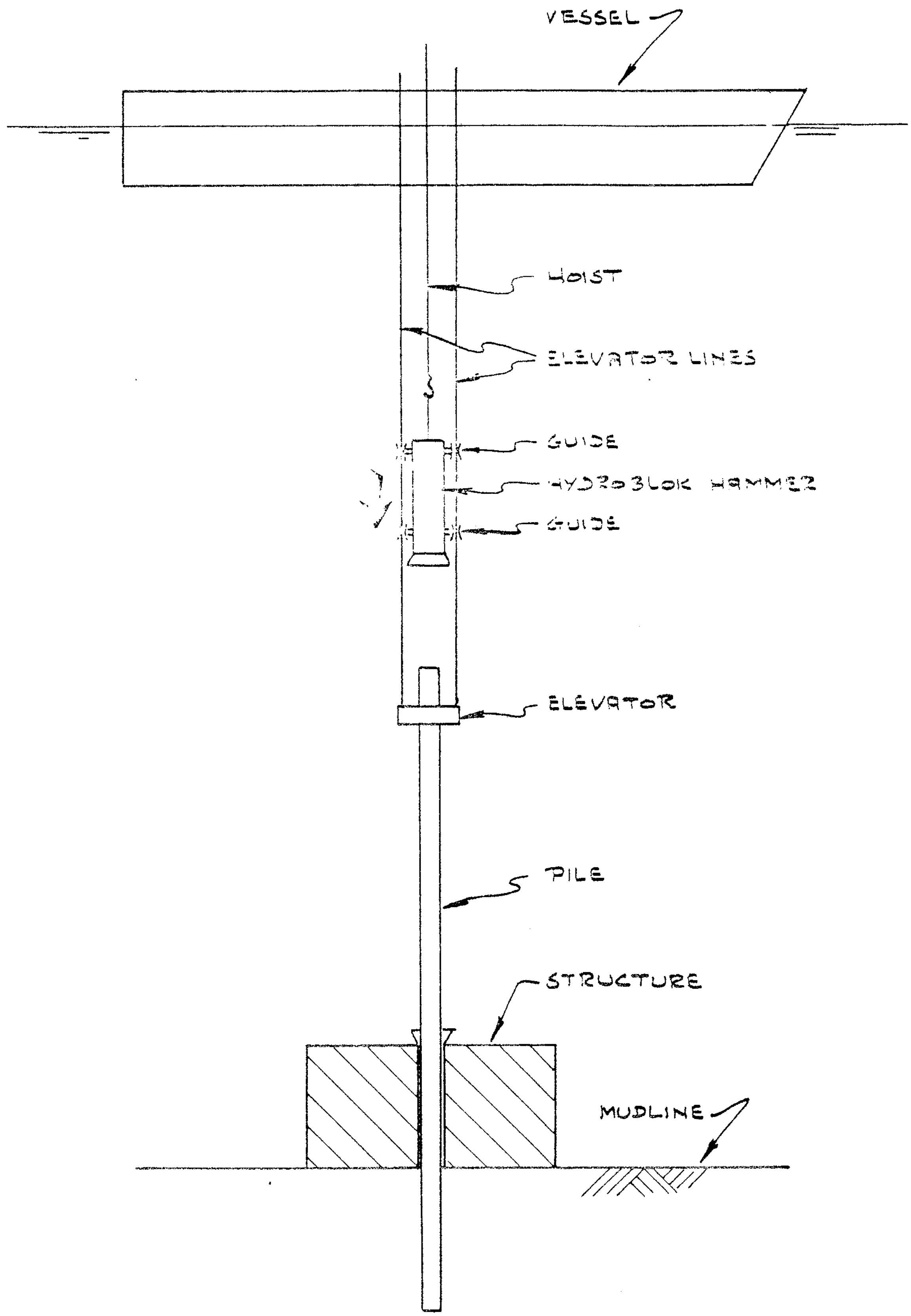
APRIL '79

LOWERING HYDROBLOK HAMMER TO PILETOP USING THE ELEVATOR LINES AS GUIDELINES



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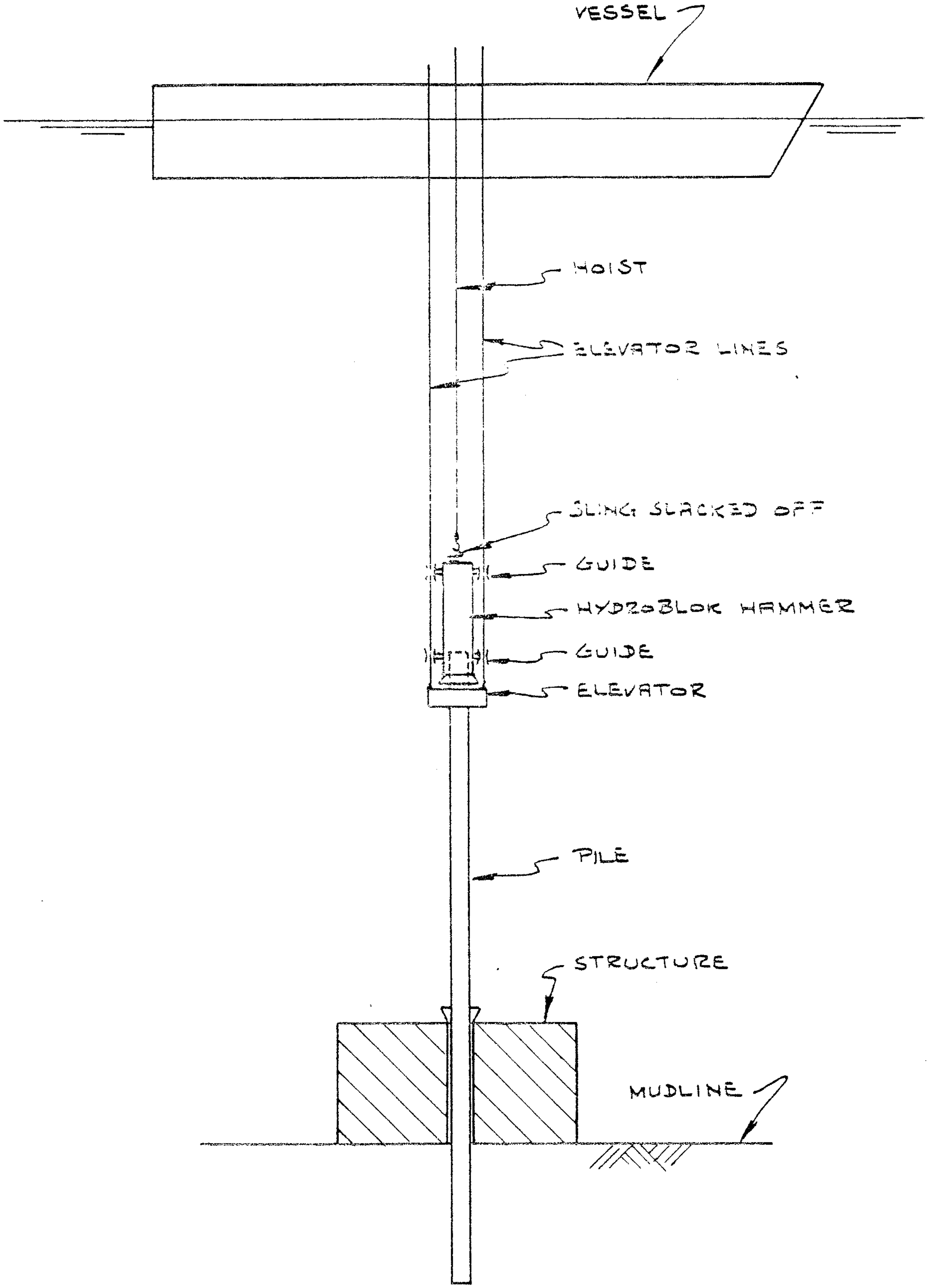
APRIL '79

HAMMER LANDED ON TOP OF PILE
SITUATION DURING DRIVING



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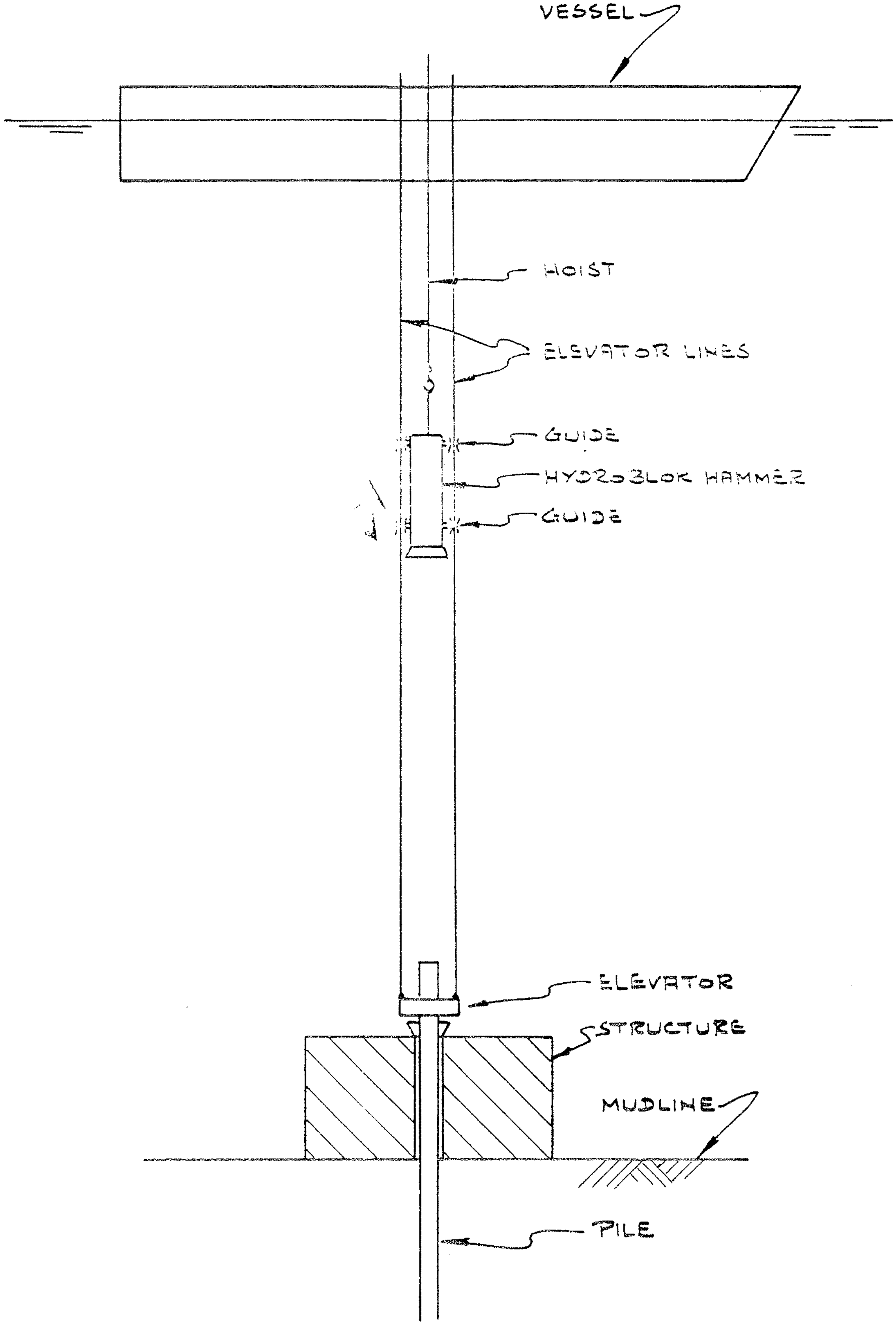
APRIL '79

PILE DRIVEN TO FINAL PENETRATION
HAMMER RETRIEVED



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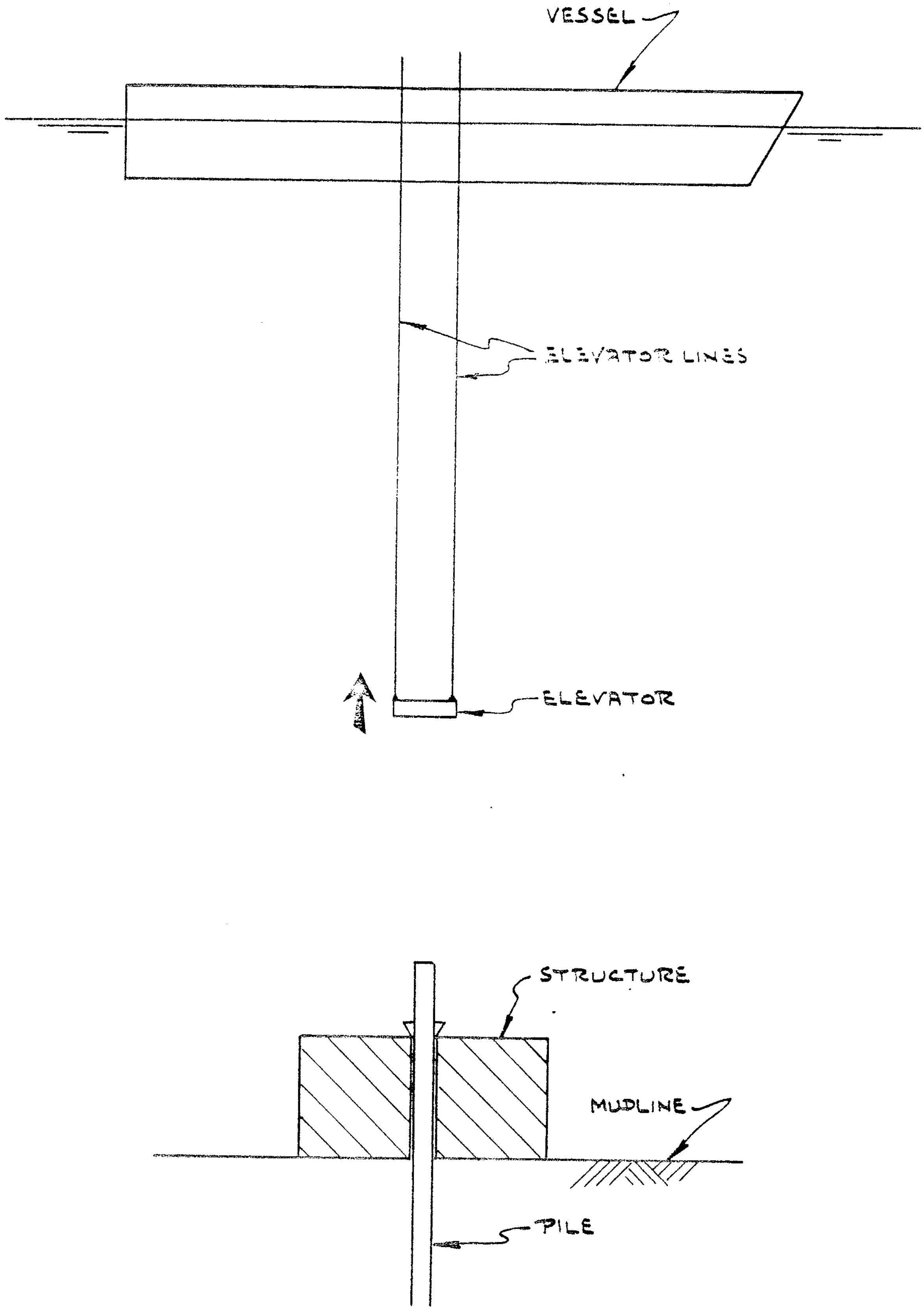
ELEVATOR REMOTELY UNLOCKED AND RETRIEVED



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APRIL '79