BSP INTERNATIONAL FOUNDATIONS LIMITED

HYDRAULIC SYSTEM

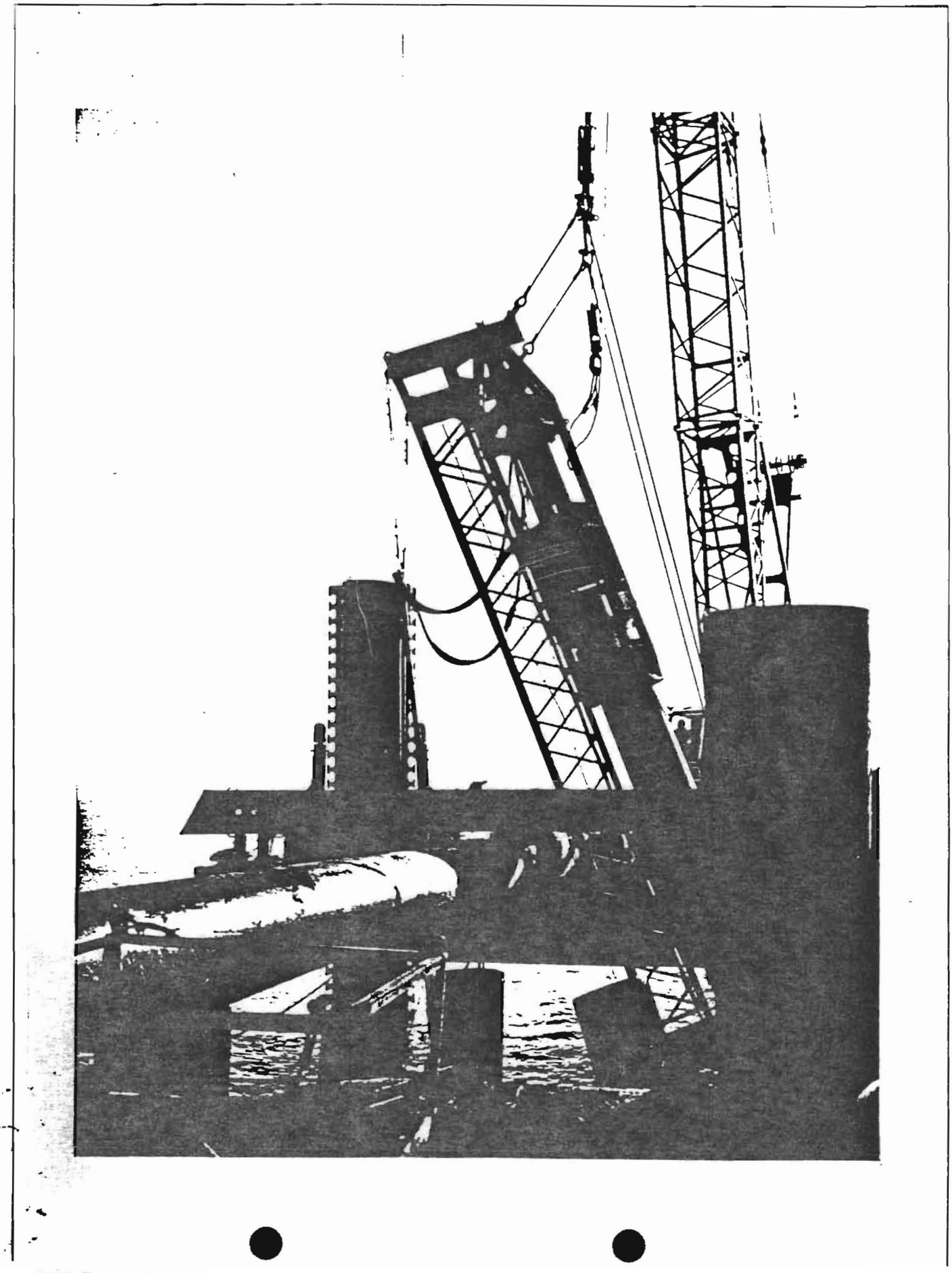
FOR

OFFSHORE PILING

BSP INTERNATIONAL FOUNDATIONS LIMITED.
Claydon, Ipswich, Suffolk. IP6 0JD. England.

Tel: Ipswich (0473) 830431. Telex: 98115 & 98460. Grams: Pilingdom.Ipswich.

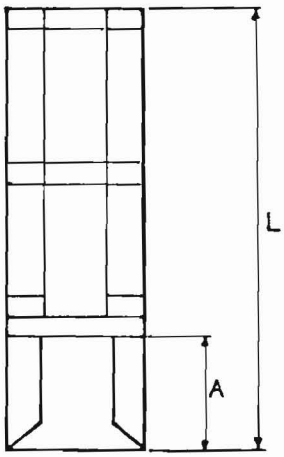
BSP 10 TONNE HYDRAULIC HAMMER (PROTOTYPE) ON SITE
AT KILLINGHOLME (ENGLAND)

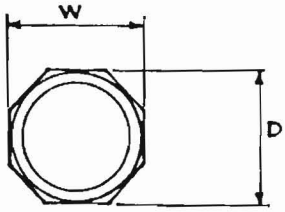


BSP HYDRAULIC HAMMER SPECIFICATIONS

OPERATING DATA			H.A.10	H.A.10S	H.A.20	H.A.40	H.A.120S
Max. Rated Energy		kN-M ft.lb.	140 103040	140 103040	280 206080	560 412160	1680 1236480
Max. Net Impact (Air) Energy		kN-M ft.lb.	133 97890	133 97890	266 195780	532 391560	1596 1174656
(Water)		kN-M ft.lb.	97 71100	97 71100	193 142200	386 284400	1160 853172
Max. Stroke		M. ft.	1.4 4.60	1.4 4.60	1.4 4.60	1.4 4.60	1.4 4.60
Blow Rate @ 1.2M Stroke			40	40	40	40	40
WEIGHT AND DIMENSIONS							
Total Hook Weight		Tonnes lbs.	19.75 43533	17 37472	35 77147	60 132252	210 462890
Ram Weight		Tonnes lbs.	10 22042	10 22042	20 44084	40 88168	120 264510
Weight Driving Cap		Tonnes lbs.	2 4408	2 4408	4 8816	6.0 13224	12 26448
Overall Length	L	M ft.	6.155 20.20	13 42.64	8.0 26.25	8.65 28.40	16 52.50
Pile Top In Guide	A	M ft.	2.060 6.75		2.060 6.75	2.060 6.75	
Hammer Width	W	M ft.	2.200 7.25	.762 2.50	2.00 6.56	2.413 8.00	2.13 7.00
Hammer Depth	D	M ft.	1.500 4.92	.762 2.50	2.00 6.56	2.413 8.00	2.13 7.0
Max. Dia. of Pile		M ft.	1.00 3.28	.762 2.50	1.5 4.92	2.13 7.00	2.13 7.00

POWER PACK		10 ton PACK	20 ton PACK
Operating Pressure	Bar psi	241 3500	241 3500
Maximum Flow Rate	L/Min. imp.gals/M	364 80	728 160
Total Weight	Tonnes lbs	4.0 8820	17.50 38573
Overall Length	M ft.	3.95 12.96	6.060 19.87
Overall Width	M ft.	1.40 4.60	2.440 8.00





THE COMPANY

BSP INTERNATIONAL FOUNDATIONS LTD., is a British Company specialising in the production of a uniquely wide range of equipment for the foundation engineering industry.

The Company was established in 1906 and built its reputation on the design and use of steel sheet piling, the development of piling methods and systems and subsequently developed as a manufacturer of pile driving equipment.

BSP now produce what is literally the widest, most comprehensive range of foundation equipment manufactured by any company in the world. Having specialised in this business for over 70 years, a unique body of knowledge has been built on the foundation business.

BSP has pioneered numerous developments in foundation engineering, which recently included the following:-

a. The introduction in 1972 of a range of Double-Acting Diesel Hammers (B range) which operates off a vacuum spring principle. This doubles the blow rate for a given energy output and effectively ensures the pile enters the ground at twice the rate it would if driven by an equivalent sized conventional Diesel Hammer.

b. In 1978 the ID17 Impulse Hammer was introduced. This grew out of the need to make quieter the piling operation. BSP were able to achieve this with the ID17 by driving against a cushion of air trapped between the ram and the anvil. The noise emitted during driving has been reduced by the ID17 from 120 dBA to 80 dBA at 15 metres.

c. The Hydraulic Actuator pile-driving system. This effectively applies modern technology to the simplest most reliable of piling tools, the drop hammer. It is the basis of our offshore hammer development.

As the more accessible areas, relatively shallow waters, of the world's known offshore oil reserves are being opened up, so oil exploration moves into deeper and deeper water. Depths at which it is considered practical to drill for oil are now up to 1000ft. deep.

The exploitation of oil at these depths requires great advances in technology and this, together with the continuing need for large steel structures, exploitation of the smaller marginal fields involving underwater pinning of templates, pipe lines and mooring facilities, lead BSP to believe that the successful development of a sub sea piling hammer for depths up to 3000 ft. has great implications for the progress of the offshore oil industry.

In the early 1970's BSP developed their first Hydraulic pile hammer (Plate I) following which a number of machines have been designed and tested. This culminated in 1976 with the Hydraulic Actuator (H.A.) which is currently being commercially exploited as a conventional land based bearing pile system (Plate II) and 5 tonne and 10 tonne versions in this form are available.

It was considered that the hydraulic mechanism would readily adapt for offshore work and so for part of its development programme in 1979, BSP obtained a grant from the E.E.C. to develop and test a series of hammers and components for under water pile driving.

THE BSP HAMMER SYSTEM

BSP's development programme will culminate in the testing of a 15 metre ton hammer in 150 metres deep water at Loch Linnhe, Scotland. In addition a 56 metre ton machine will have been manufactured and tested at the factory together with all the necessary components which would be used in a 180 metre ton hammer.

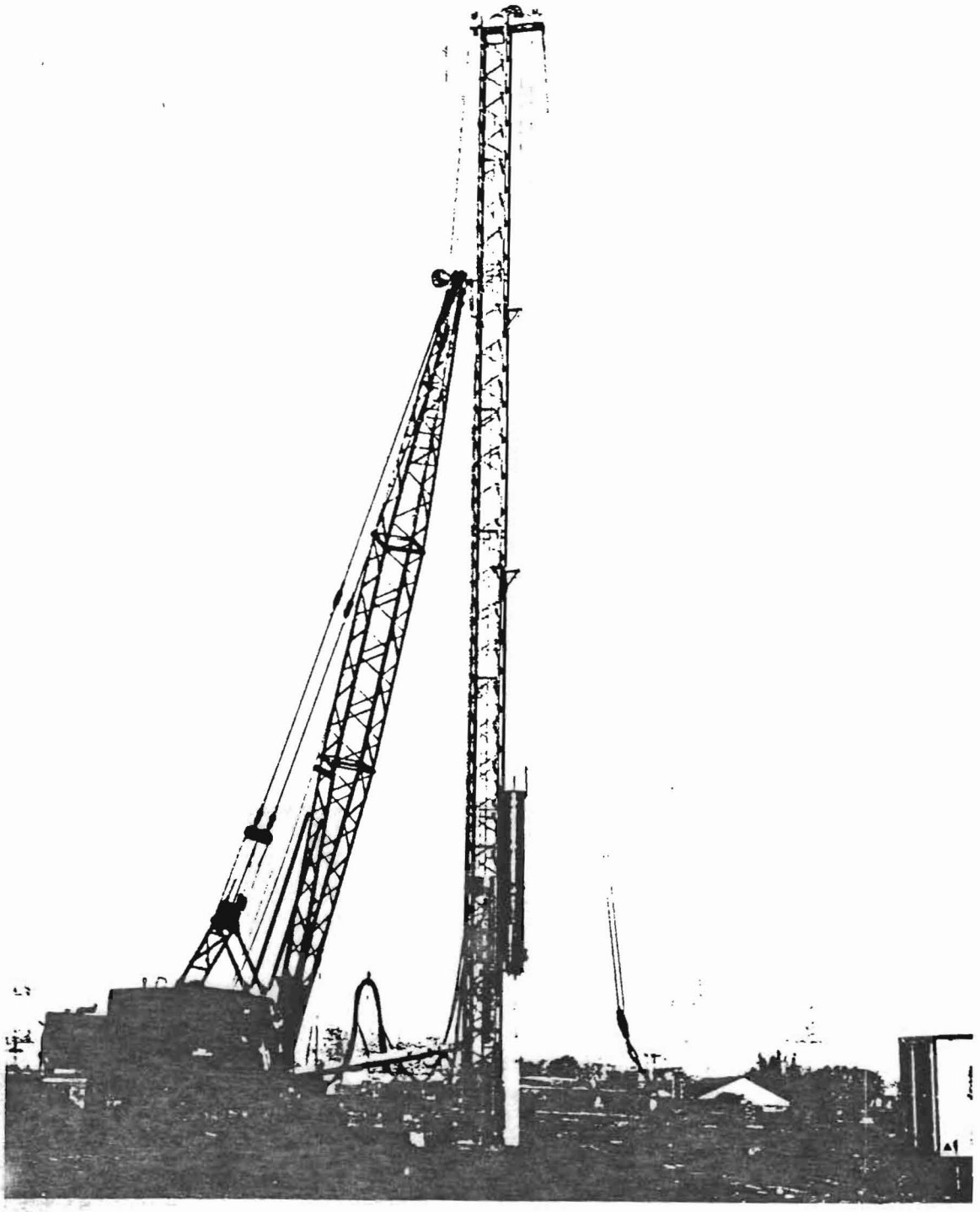
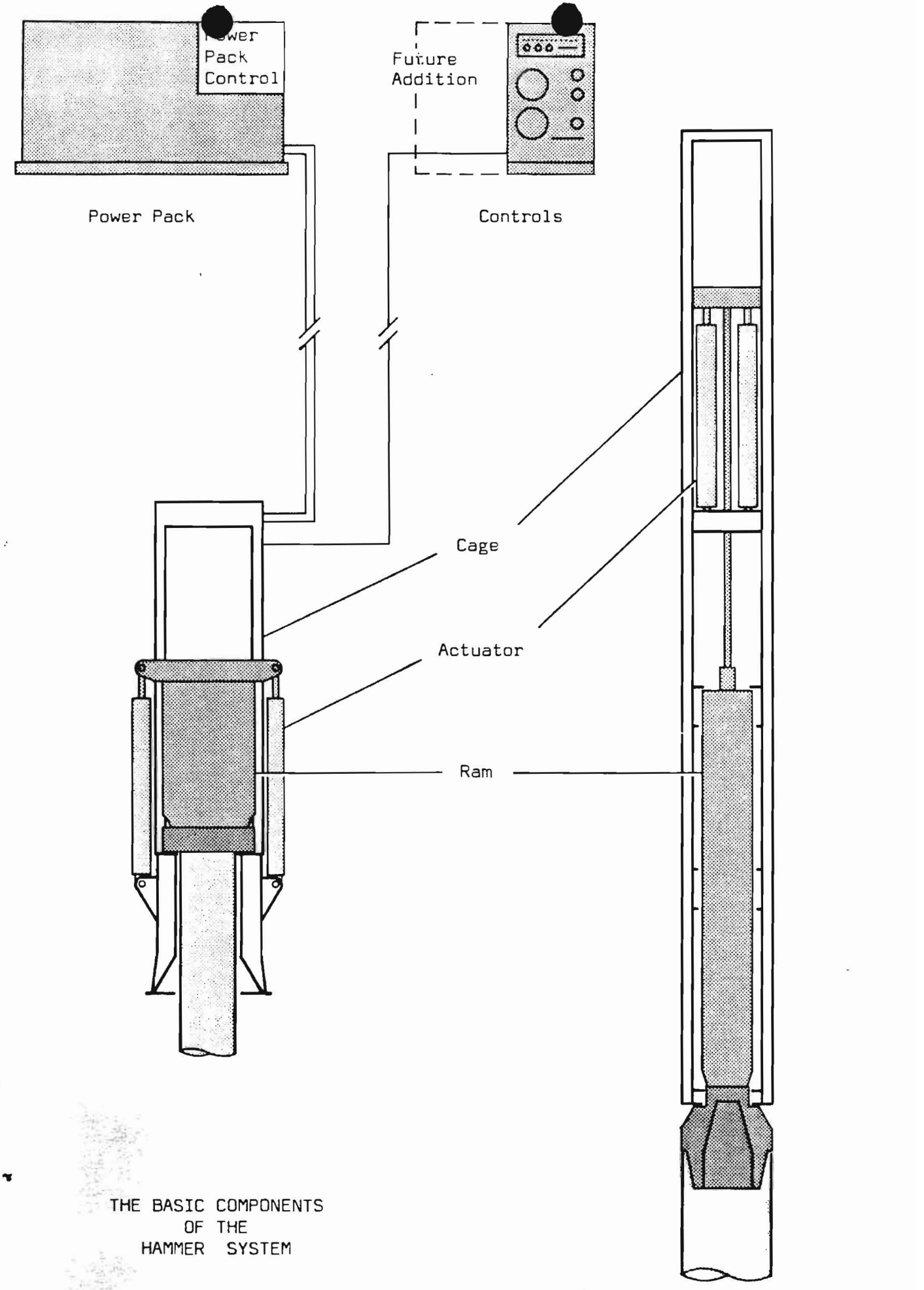


Plate II



THE BASIC COMPONENTS
OF THE
HAMMER SYSTEM

coupled together in various configurations to suit different piling requirements. These are:-

1. The Hydraulic Actuator:
2. The Power Pack
3. The Hammer or Ram
4. The Hammer Cage
5. The Controls

FIG. 1.

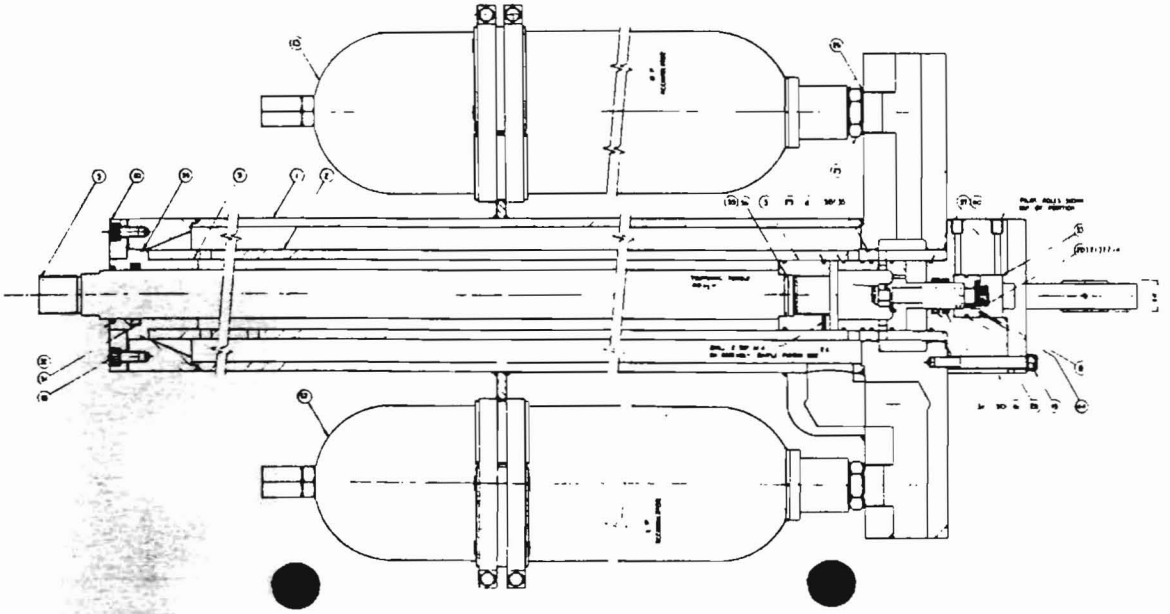
The Hydraulic Actuator — Plate III

The main component of the whole system is the Hydraulic Actuator. BSP have designed three basic sizes, 5 tonne, 10 tonne, and 20 tonne, which can be operated to give ram strokes that are variable between 0.3 and 1.5 metres.

The hydraulic cylinder is activated by the switching of a 2 position solenoid operated control valve that enables high pressure hydraulic fluid to accelerate the piston rod. (Fig. 2).

When the piston rod has moved a pre-determined distance dependant on stroke the valve is activated to stop the inflow of high pressure fluid. The ram decelerates to the top of its stroke allowing the hydraulic pressures in the circuit to equalise themselves.

The hammer ram is then allowed to free fall pushing the piston rod back in the cylinder ready for the next stroke.
These actuators can work singly or be coupled together to work in multiples of up to six.



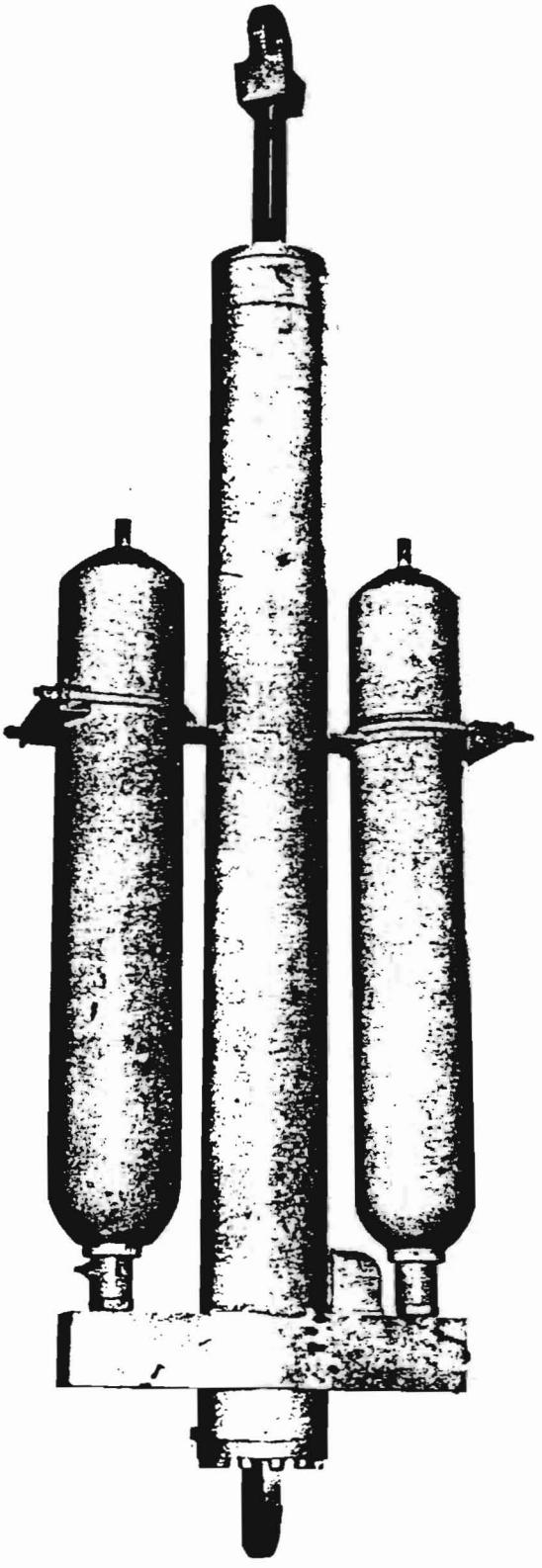


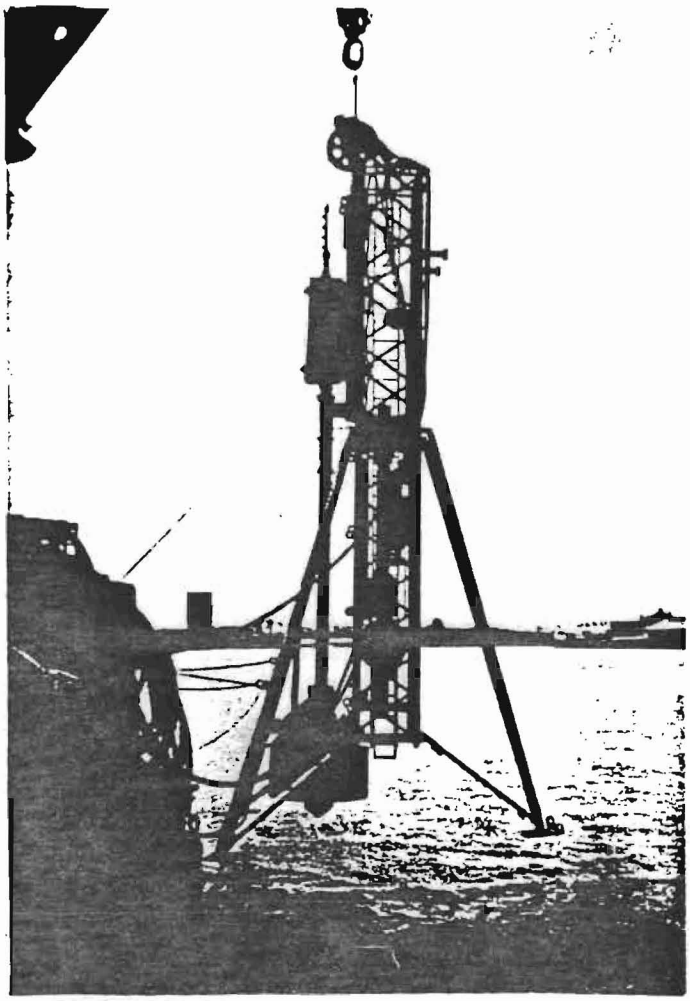
Plate III

The hammer can be varied in weight and shape to suit the piling requirements. Due to the many variations that could be applied, BSP have selected two basic forms for development:-

1. The conventional caged version for top driving piles and with the ability to drive under water. (See Drawing No. 71300 of the 40 ton ram hammer).

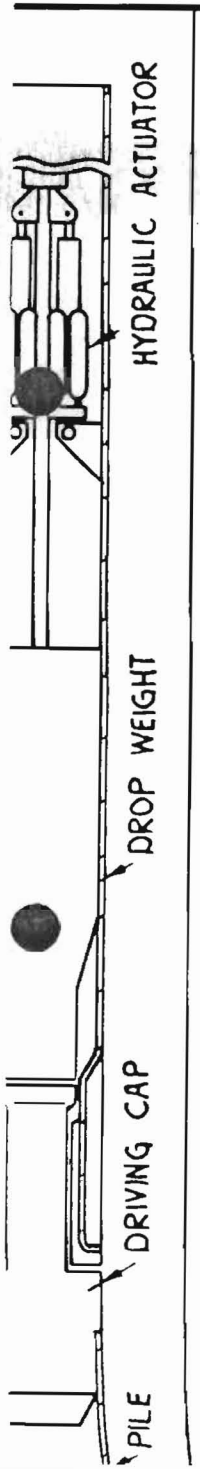
2. A narrow caged version suitable for under water work and of being able to be used inside a 762mm (30") i.d. casing (See Drawing No. 71357).

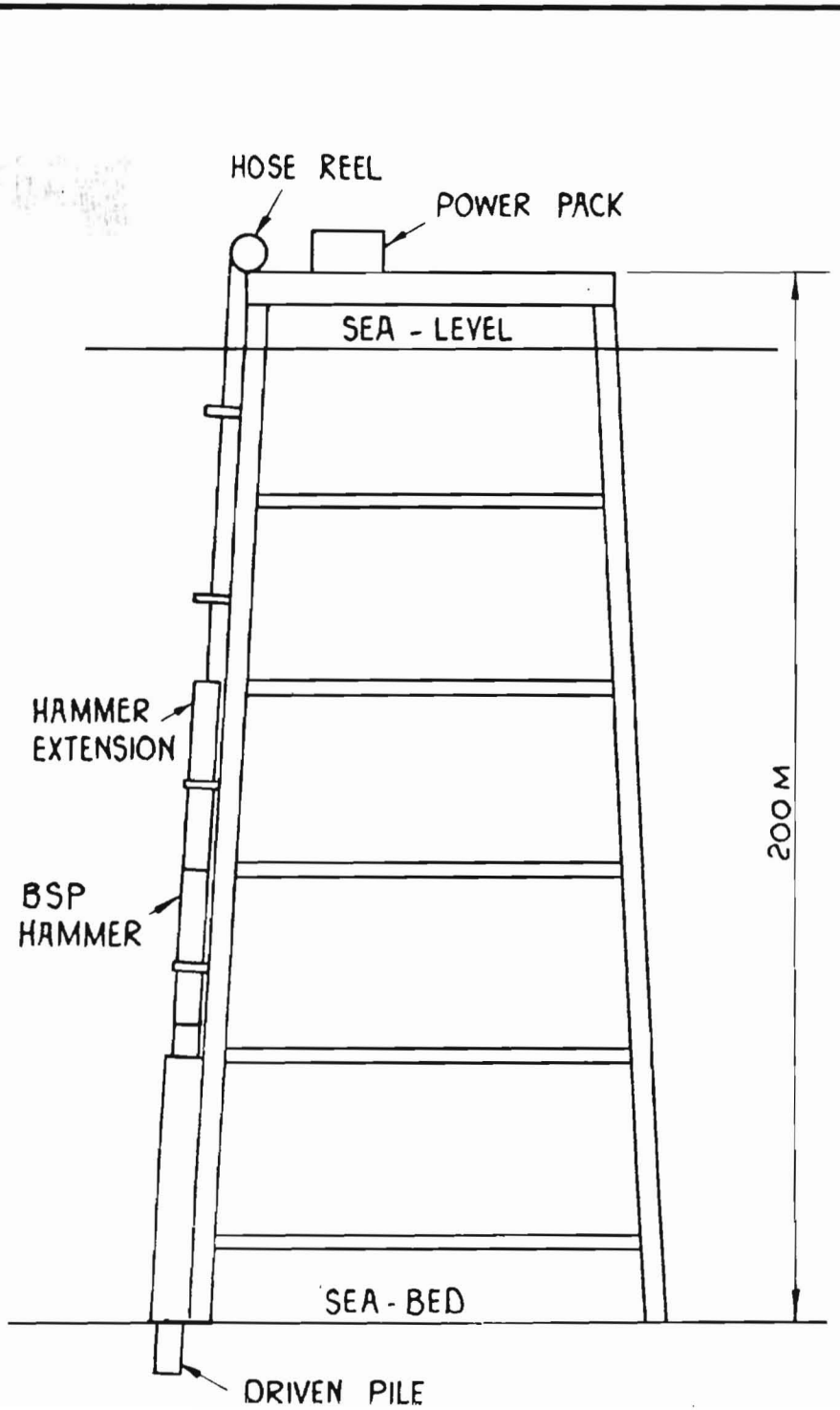
This is the prototype machine and it would develop 15 metre tonnes of energy per blow. It and larger ones of this form would pass through the pile guides on the platform and work under water on top of the pile, at the toe or at an intermediate level. (Figure 3). In addition, because it is intended to scale up by increasing the number of hydraulic actuators rather than increase the size, much of the development work for the 200 metre tonne hammer will have been completed.

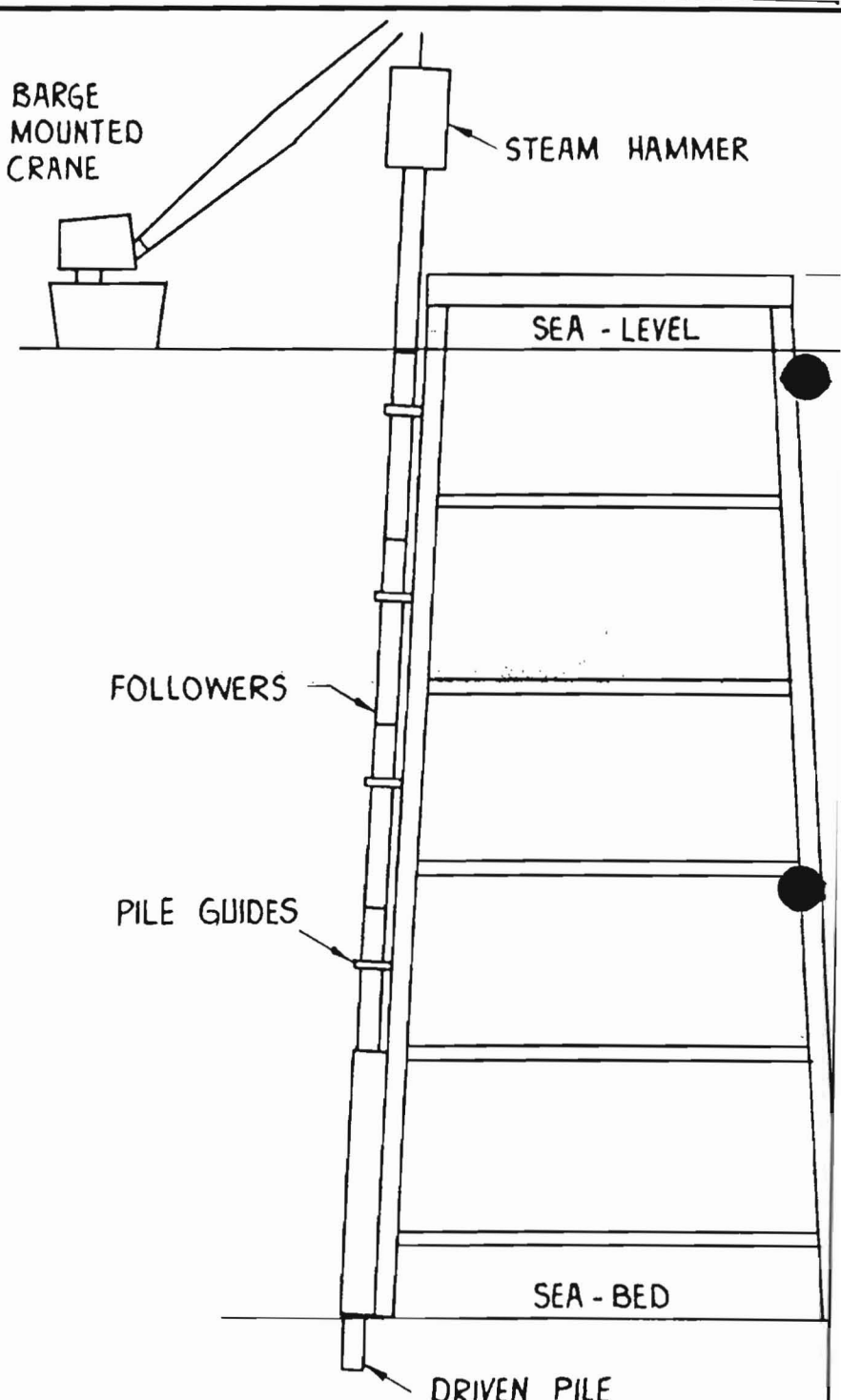


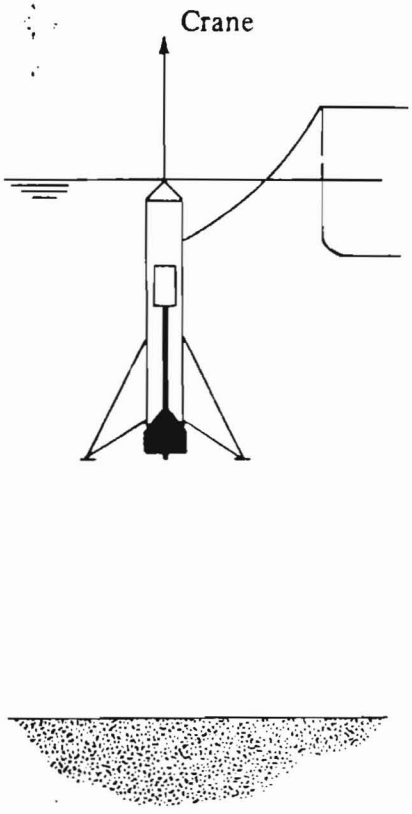
Commercial use has already been made of a BSP Hydraulic Actuator in an underwater situation. A special short frame with Drop Hammer and Actuator was supplied to QMC Anchor Technology Ltd., for installation of their Anchor System (Plate IV). The equipment can be handled from a small vessel without recourse to specialist piling barges.

Plate IV

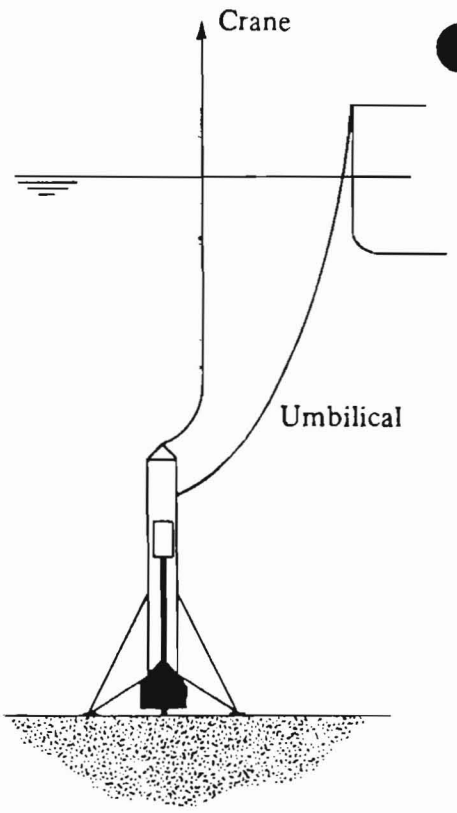

HYDRAULIC ACTUATOR
DROP WEIGHT
DRIVING CAP
PILE


HOSE REEL
POWER PACK
SEA - LEVEL
HAMMER EXTENSION
BSP HAMMER
200 M
SEA - BED
DRIVEN PILE

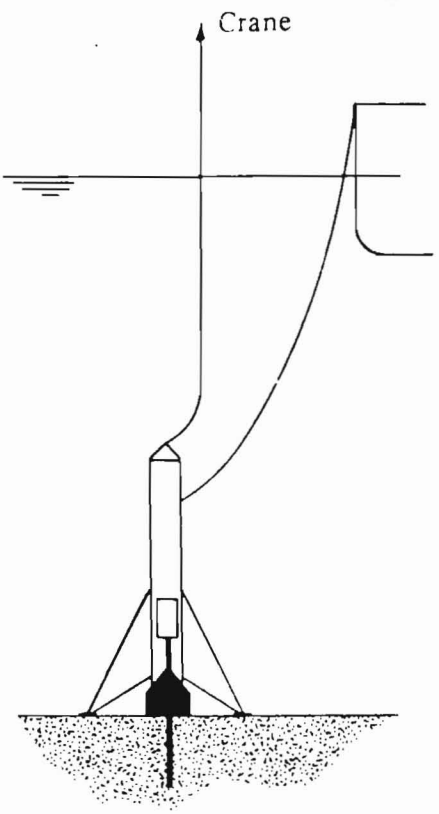

BARGE MOUNTED CRANE
STEAM HAMMER
SEA - LEVEL
FOLLOWERS
PILE GUIDES
SEA - BED
DRIVEN PILE



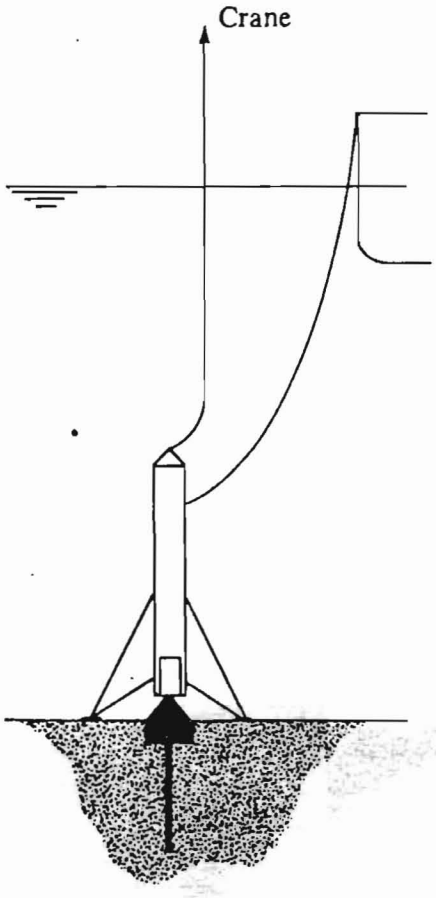
1. Pile and Installation Rig lowered to sea bed.



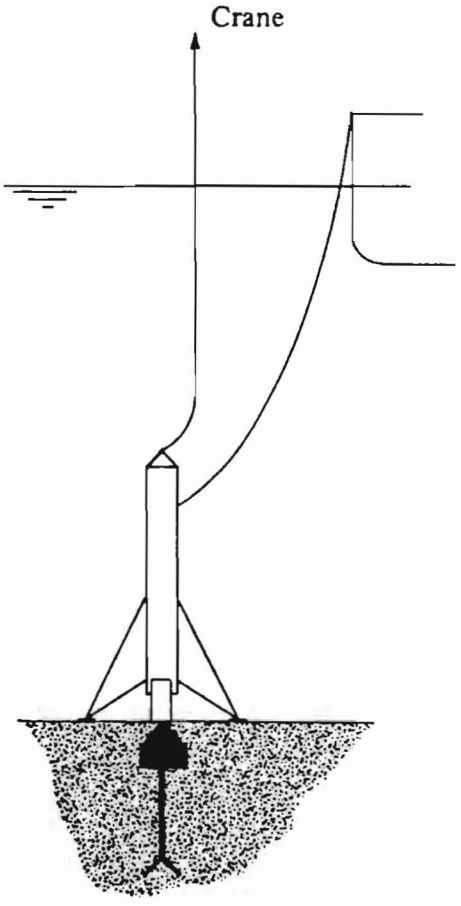
2. Pile and Installation Rig on sea bed; precise vessel location no longer necessary.



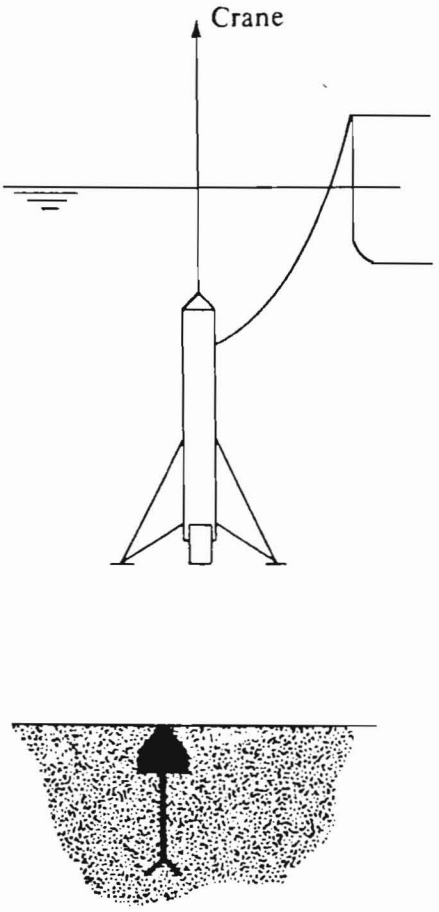
3. Shaft and locked Flukes driven through Thrust Plate



4. Thrust Plate driven with Shaft and Flukes



5. Flukes unlocked, driving completed.



6. Installation Rig recovered.

The Hydraulic Power Packs match each size of actuator. They can be coupled together in parallel to match the number of actuators being used. We envisage the following:-

Ram Size	Power Pack Supply	Max. Pressure	Max.Blow Rate at 1.2M/stroke
5 tonne	40 g.p.m.	3500 psi	40 blows/min.
10 tonne	80 g.p.m.	3500 psi	40 blows/min.
20 tonne	160 g.p.m.	3500 psi	40 blows/min

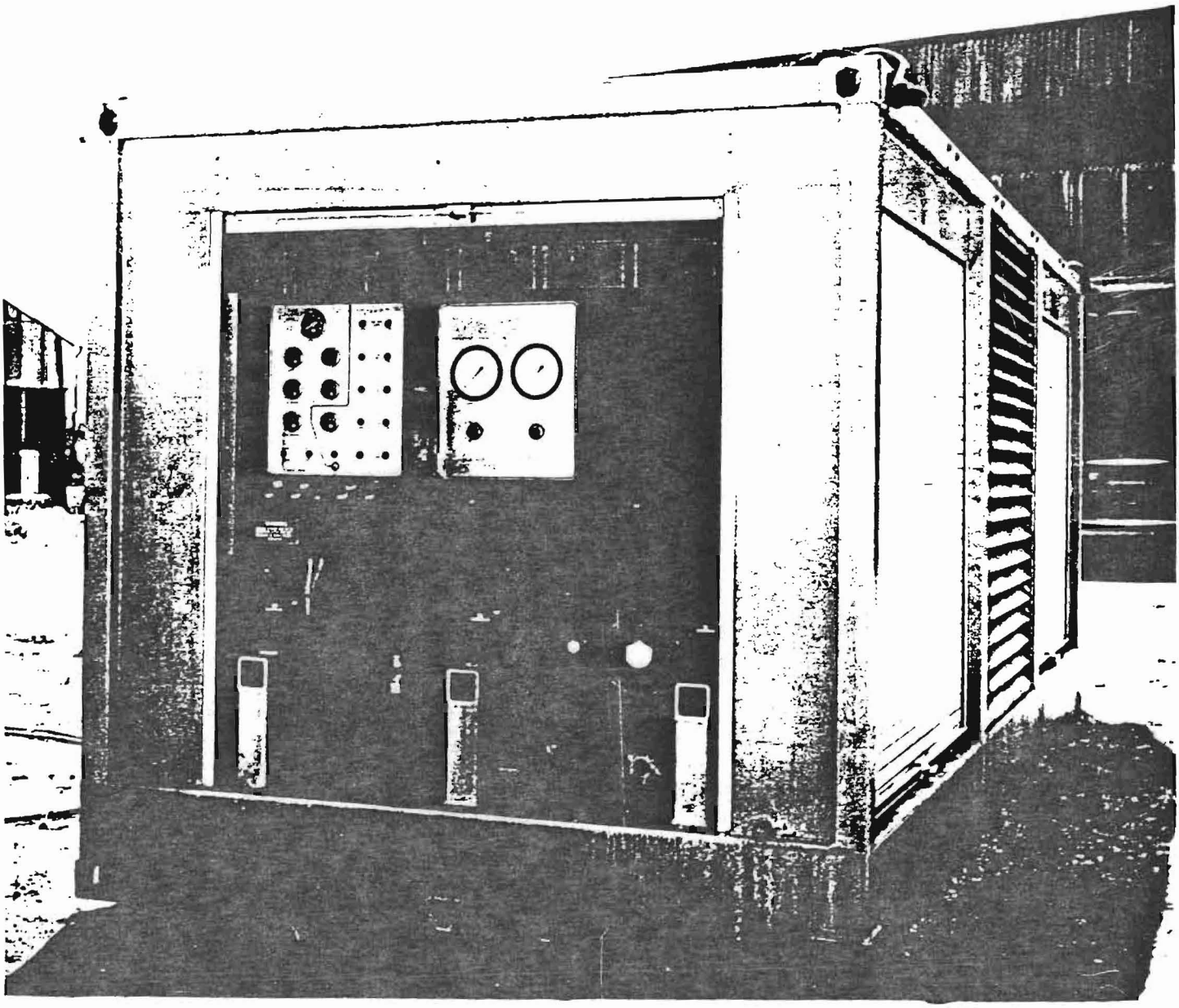


Plate V

The whole system is controlled by a remote electric hydraulic system which allows for both manual single blow operation and fully automatic sequence.

They enable the stroke to be varied from 0.3 to 1.5M during operation and allow for the blow count to be varied to suit individual circumstances. The height of stroke and blow count will be indicated at the surface at all times. The maximum blow rate at 1.2M is 40 blows/min.

The velocity at impact is recorded on an oscillascope and provision is made to indicate the penetration/number of blows (say 10) with a manometer.

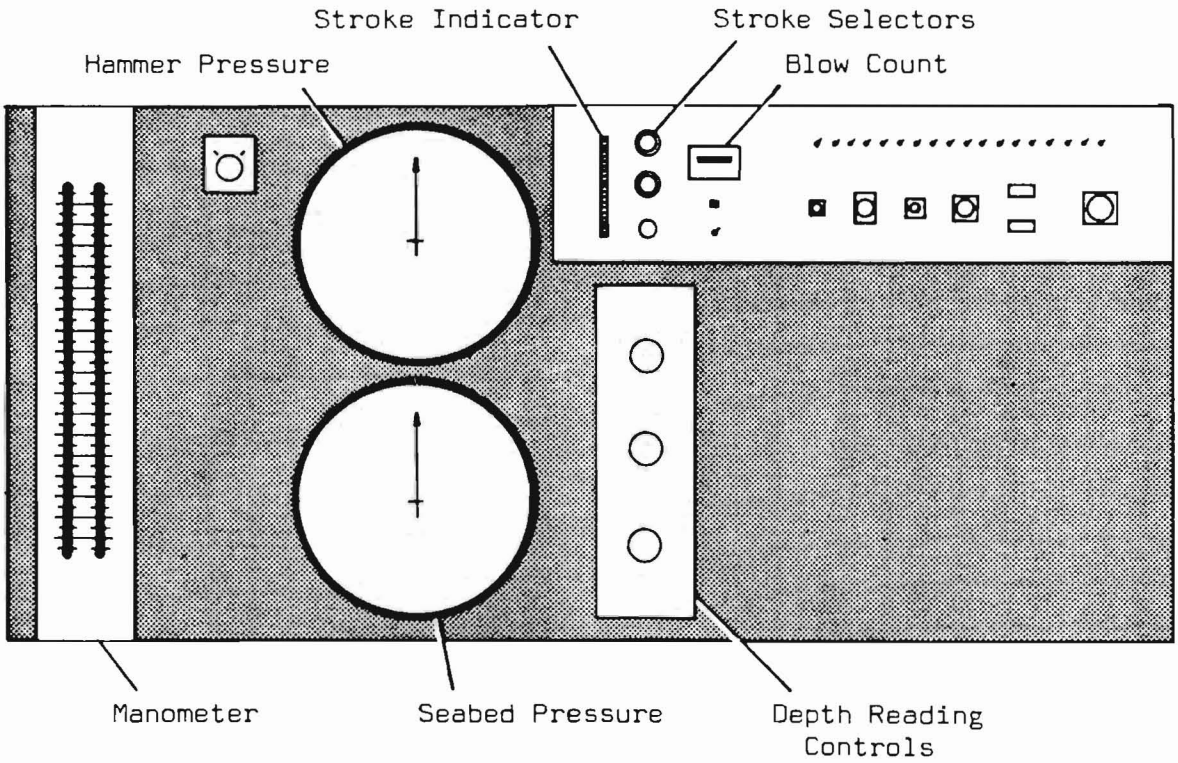


Plate VI

In extensive tests carried out at BSP's factory the following efficiencies have been established for hammers of the type that have the actuators coupled direct to the ram.

When working in air - 95% of the rated energy.

When working in water - 69% of the rated energy.

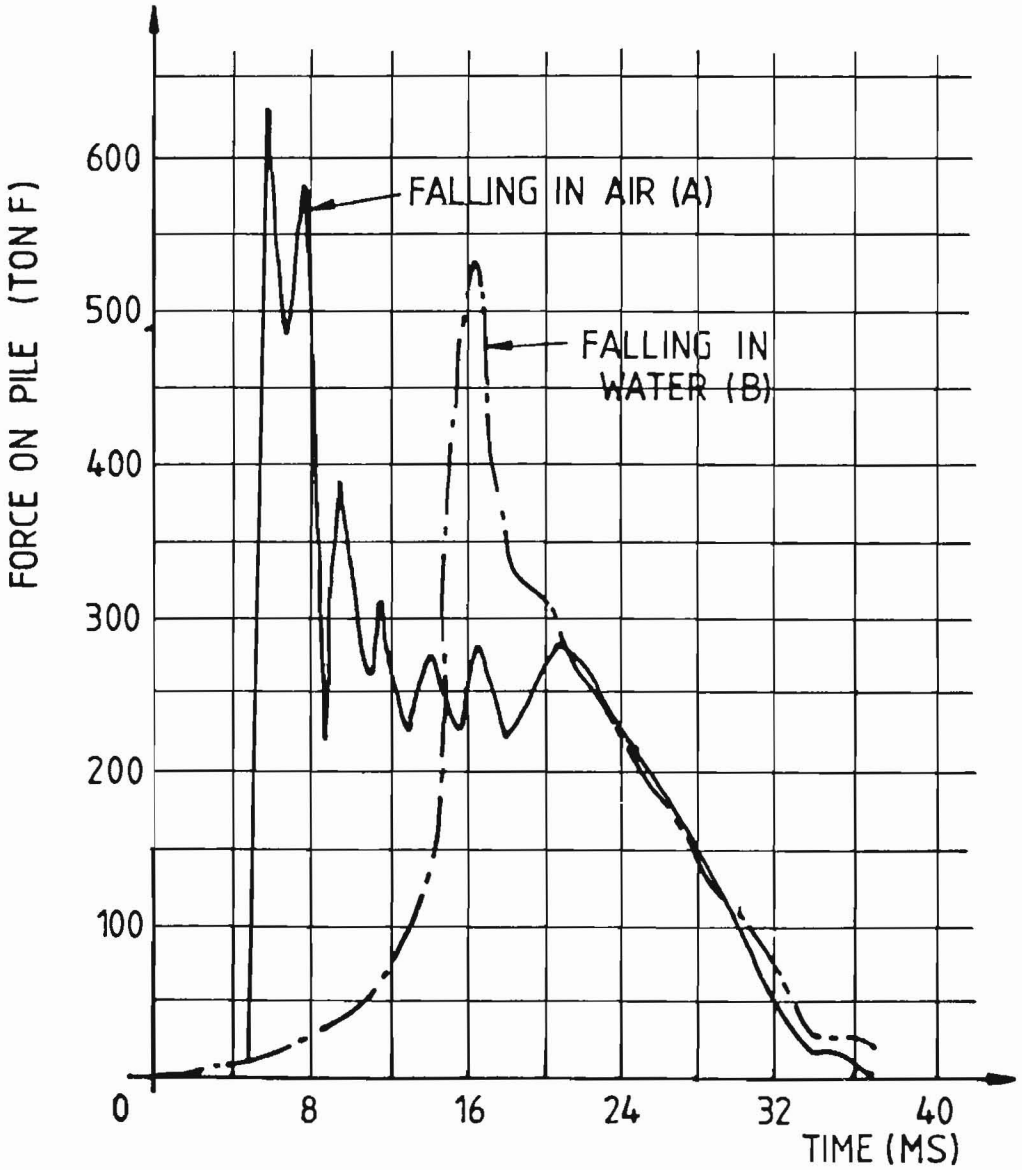
If parasite weight were added to the ram to counteract the bouyancy effect then the efficiency when operating in water would be increased to 79% of the rated energy. (Fig. 6).

10 TON DROP WEIGHT FREE FALL

Stroke 48 ins.

A. Force transmitted to pile with hammer operating in air.

B. Force transmitted to pile with hammer operating in water.



Force-Time Diagrams

Force i[illegible]ced in 30 ins. dia. Pile x 15[illegible]. long

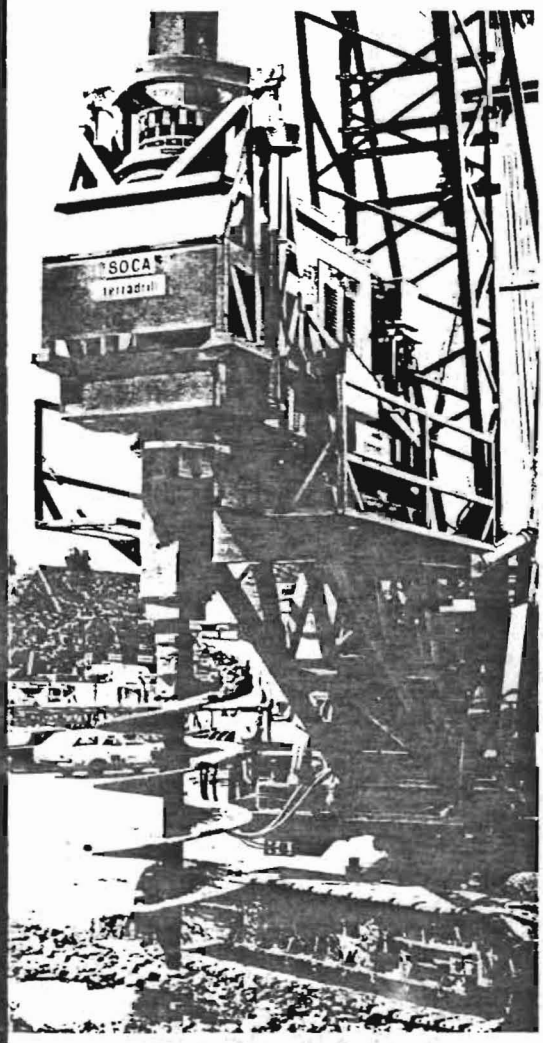
The implications for the offshore oil industry of BSP's newly developed underwater hammer are, we believe, very substantial.

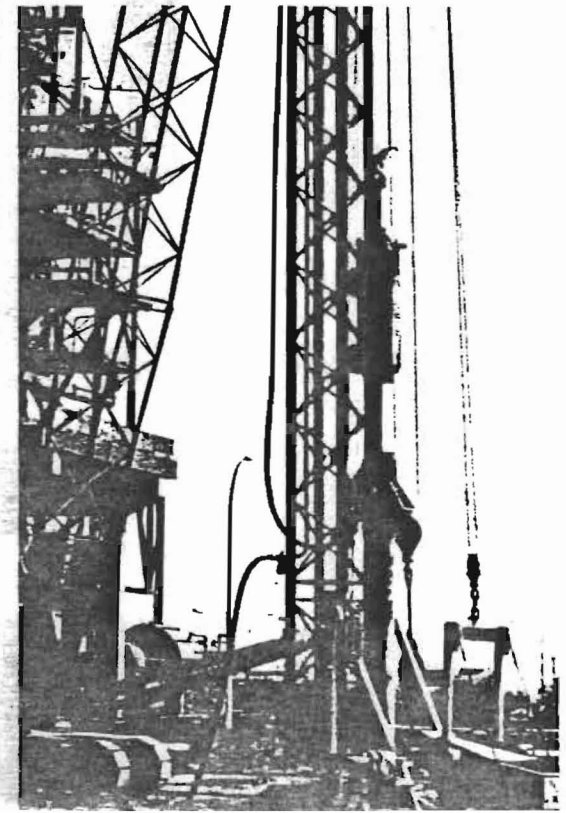
The design of the hammer gives the facility to manufacture the weight, length and diameter of the hammer to the requirements of both the design engineer and the installation engineer. With the basic elements of the hammer consisting of only hydraulic actuators and a drop weight it will only be necessary to carry spare actuators and not a complete hammer as provision against breakdown.

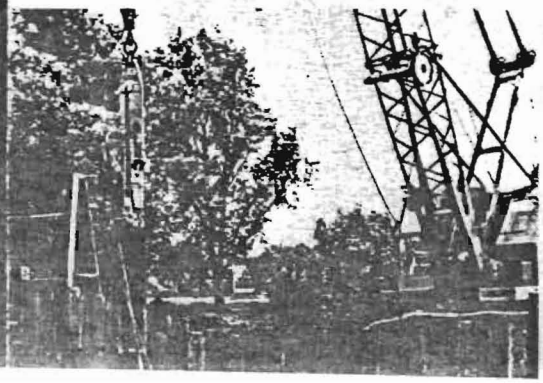
Hydraulic Hammers with the features described bring about significant financial savings by ease and simplicity of operation and service, safety, reducing dependence on weather conditions and reducing the material requirements of offshore structures.

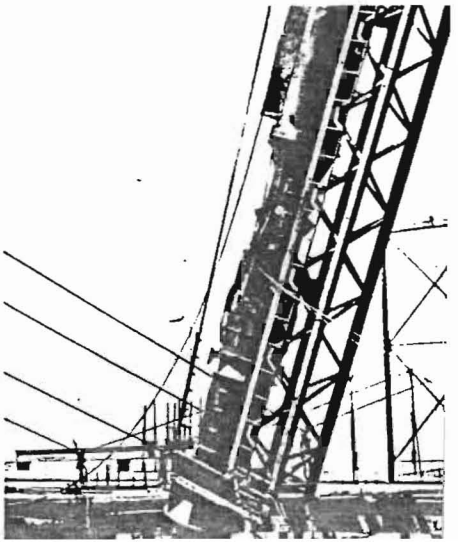
For the first time a specialist British company with a vast store of knowledge of pile driving has developed the technology to drive piles underwater to depths up to 1000ft. and is confident that its technology can be extended to 4000ft. and more.

bsp the world's widest range of foundation equipment





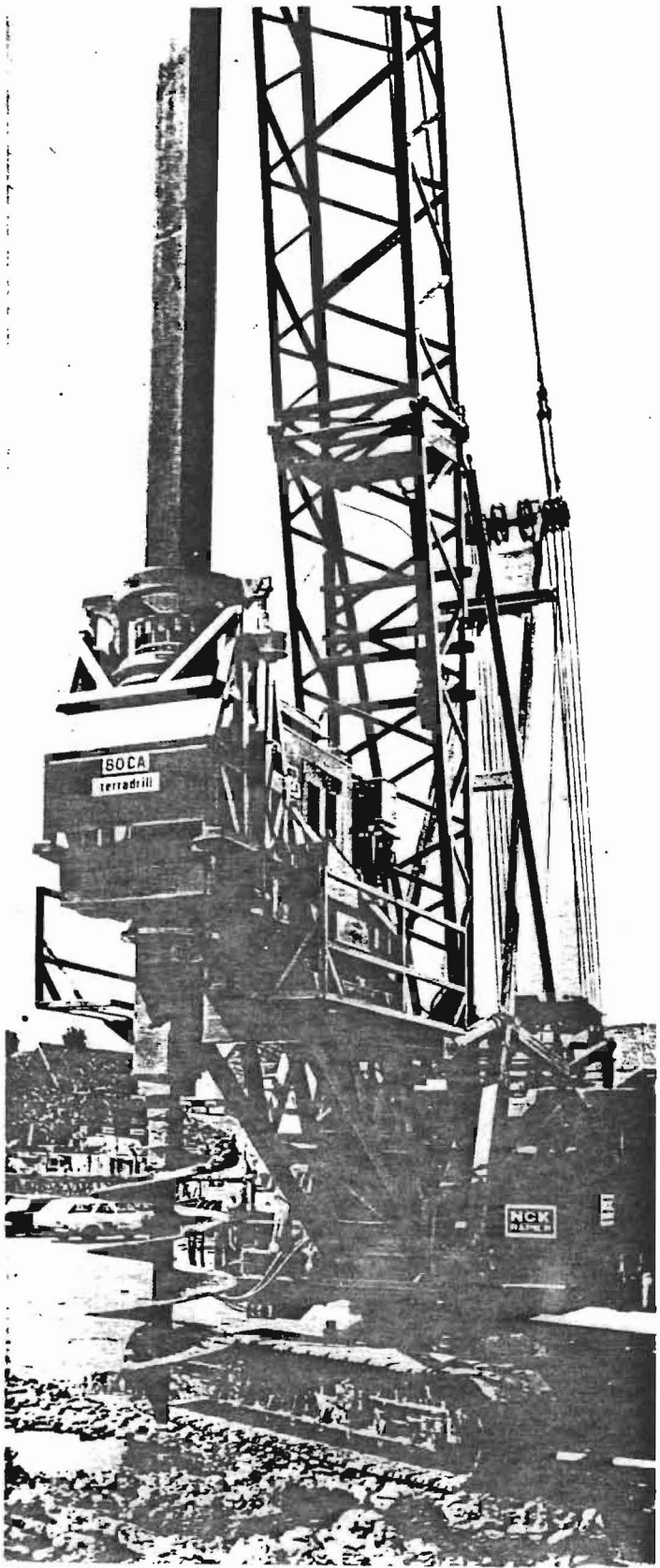




BSP world leadership

The foundation equipment shown in this folder gives an idea of both the extent and the efficiency of the BSP range. The equipment is the result of a continuous programme of research and development. An important part of this development has been the close co-operation with our clients in solving problems in most countries throughout the world.

The range is such that you can select from it precisely what is most suitable for specific conditions and requirements. Advice given by BSP on civil engineering problems is followed by practical guidance in the field, with the full support of comprehensive spares and servicing.



The BSP Range of Terradrills

The range of BSP Terradrill equipment covering crane attachments, high and low ring gear, lorry mounted machines, buckets, augers, special tools, and circulation equipment offers the foundation contractor the widest selection of depths and diameters for most conditions.

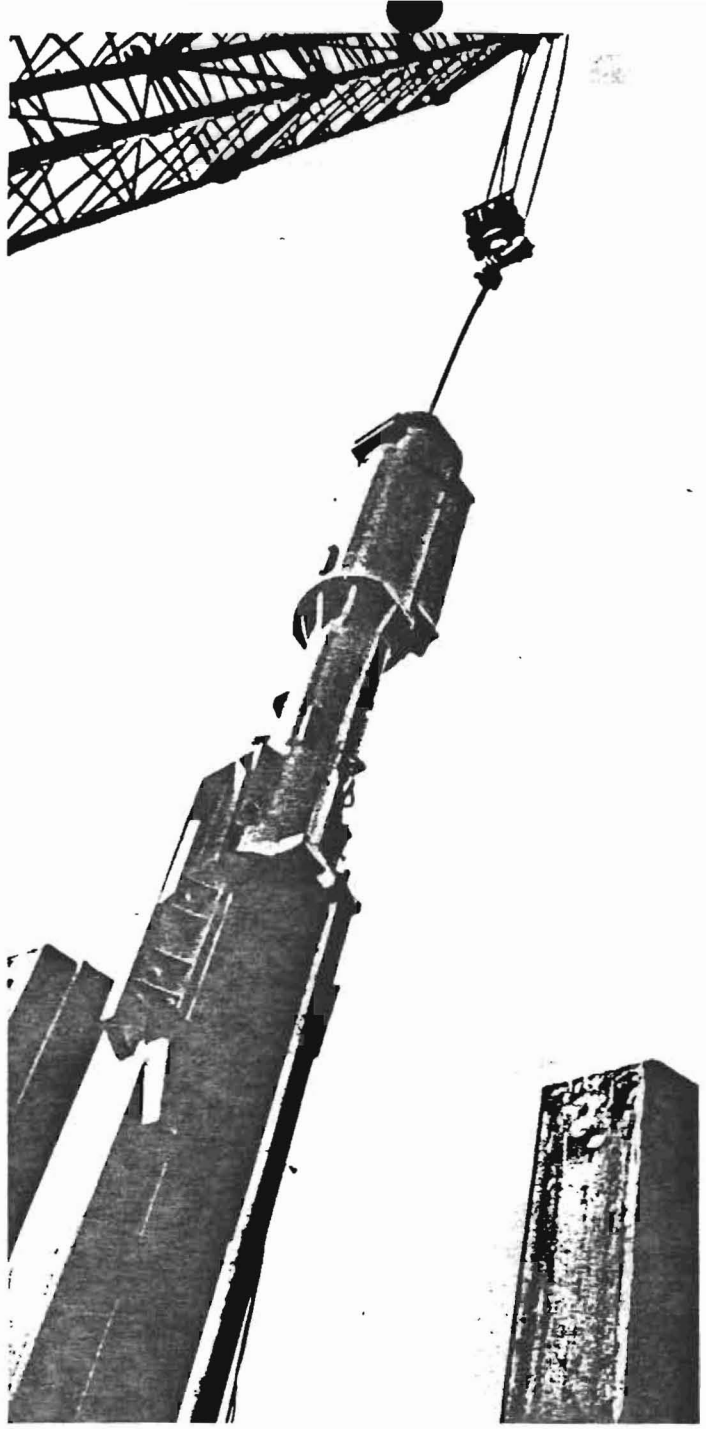
The newcomer to the range, the lorry mounted bucket Rig TTM 80 B, has a depth potential of 30m as standard (40m on request) and a stall torque of 8,000 kg.m. Maximum drilling diameter is 1.3m or 2m with reamers.

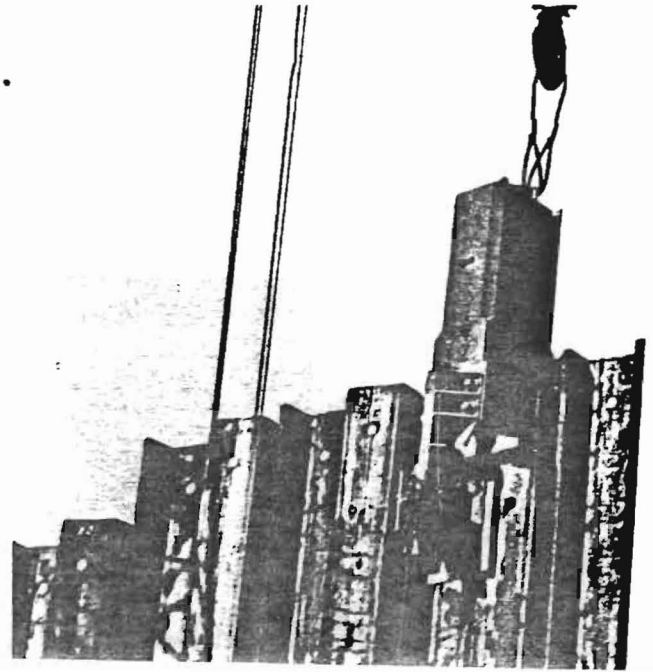
Whether or not to use large diameter bored piles on a particular contract is decided by economic and practical feasibility. Low labour costs and reliability associated with Terradrill operation can provide continuous working and high profitability.

The expertise derived from unrivalled specialisation in drilling for heavy foundations is freely available to contractors, engineers and architects.

We invite you, as a prospective user of Terradrill equipment, to make the fullest use of our consultative service.

MODEL	625	1250	TCA110
Weight (less kelly & tools) kg	3098	5770	7000
Max drilling diameter with bucket and reamer mm	1525	2440	3500
Max drilling torque kg m	2760	7450	11000
Single line pull capacity kgs	4550	7940	12500





BSP double-acting diesel pile hammers

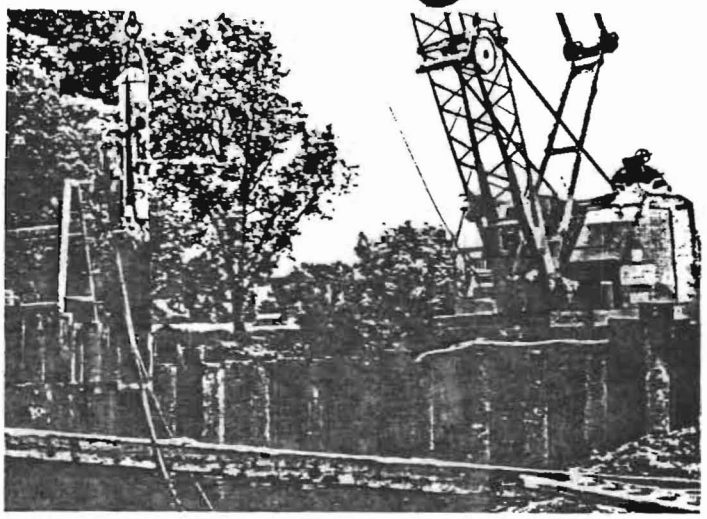
Each hammer in the BSP 'B' range has a horsepower-to-weight ratio well in excess of any comparable hammer on the market. The patented vacuum return spring makes them the most efficient pile hammers at lowest cost per work done. At 80 to 100 blows per minute they work twice as fast as other diesel hammers of similar energy per blow. Easy control of output energy is provided by the fuel pump throttle which is infinitely variable to suit driving conditions. The driving of sheet steel piling is facilitated by legs and inserts available for the hammers.
The use of BSP leaders and hammer back guides enables the hammers to drive bearing piles of all types.
For full technical details ask for leaflet.

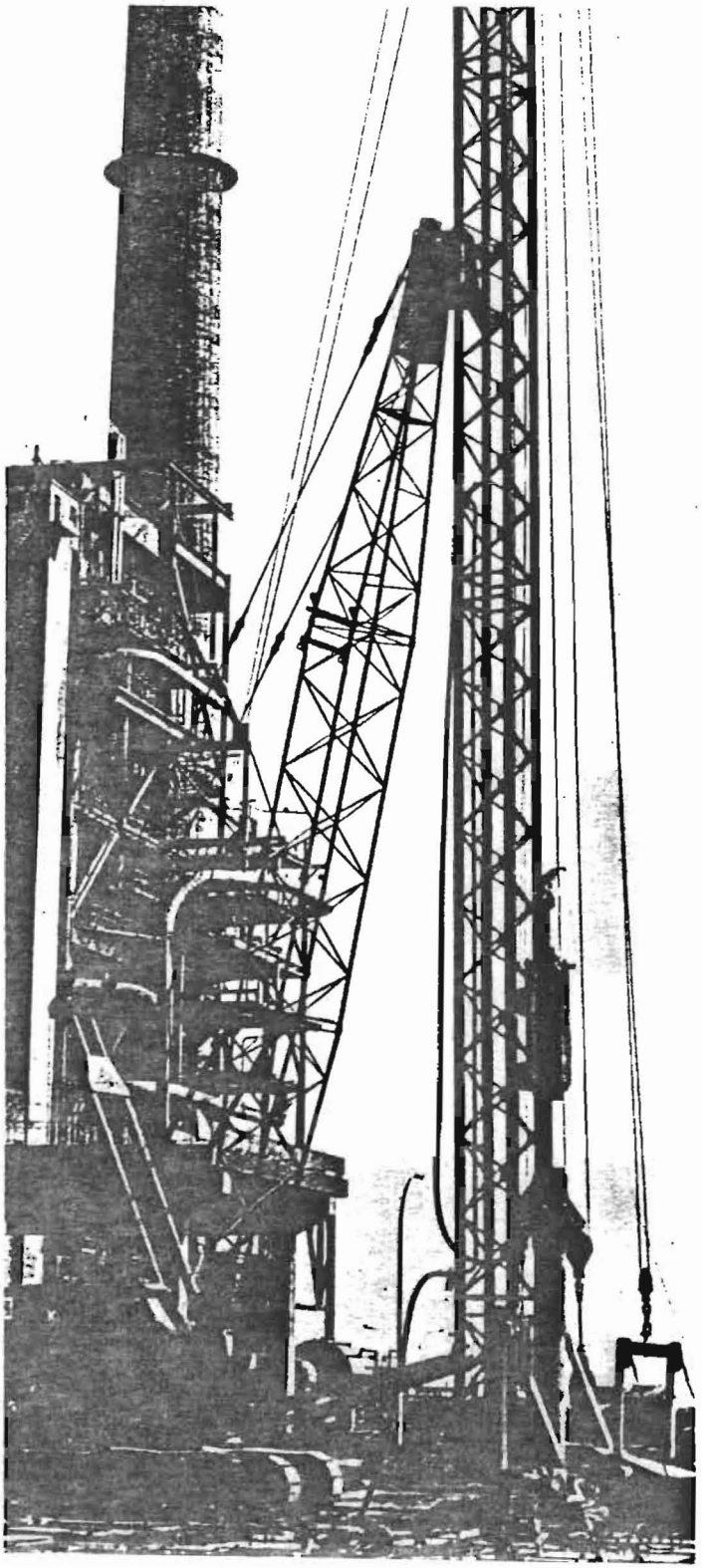
MODEL	B15	B25	B35	B45
Weight of ram kg	1500	2500	3500	4500
Energy per blow m kg at 80 blows/min	3790	6320	8850	11400
Kinetic energy/min at 80 blows/min m kg	303000	505500	708000	912000

BSP double-acting air hammers

Hammers in the range have been designed to operate at maximum efficiency when used with standard sizes of compressors normally available to contractors.
The 'N' hammers are outstandingly robust because the body is cast in one piece and there are only two moving parts – the ram and valve spool. And a simple lubricating system enables the hammer to run for long periods in severe conditions with minimum attention.
'N' hammers have a pneumatically operated leg grip which maintains a strong purchase on the pile. This grip makes it possible for the frequency and energy of the blow to be much increased by means of the patented high-pressure bounce chamber.
The hammer drives pairs of sheet piles or can be quickly adapted to drive single sheet or bearing piles.
For full technical details ask for leaflet.

MODEL	200	300	500N	600N	700N
Weight of ram kg			90.7	227	385
Blows/min	500	400	330	250	225
Max kinetic energy m kg	22	48	165	415	650
Recommended compressor	2m³	3m³	7.07m³	10.3m³	17m³





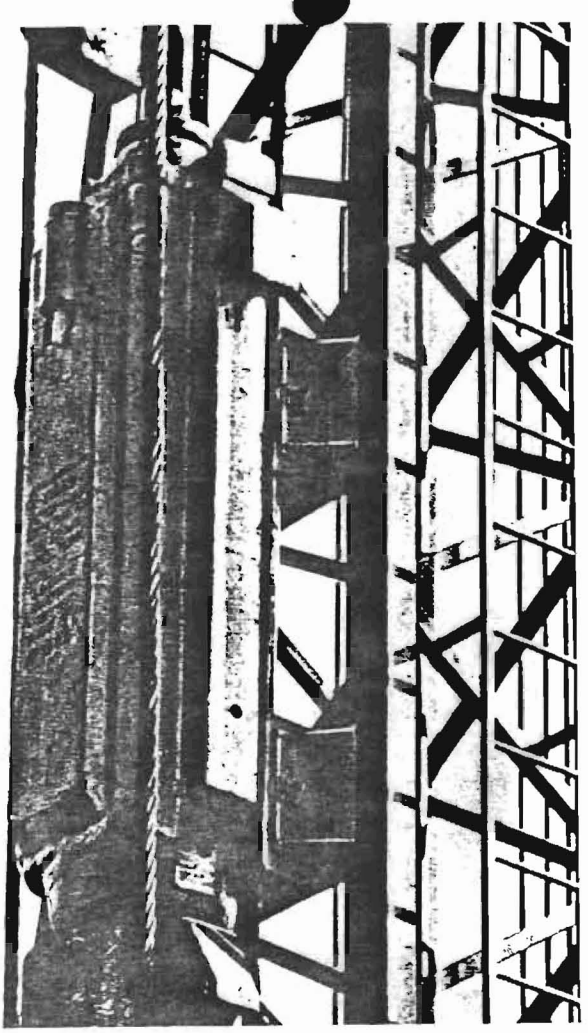
The BSP Range of Extractors

For the Contractor the recovery of steel piles means great savings in cost. The BSP Range of purpose-built extractors enables piles to be recovered in the most efficient way from the lightest to the heaviest.
Four sizes cover all pile extracting requirements and extend from the high impact energy of the lightweight HD2000 to the most powerful impact extractor in the world, the HD15.
The three largest extractors will operate off either steam or air although the latter is more generally used.

MODEL	HD2000	HD7	HD10	HD15
Weight of ram kg	227	520	750	1750
Blows/min	200	150	160	120
Compressed air consumption	3.5m³	7m³	10m³	13m³
Kinetic energy per blow m kg	275	770	1100	1650

The BSP Vibropile cast-in-place system

The system provides world-proven concrete piling for high production coupled with low cost. Piles are made to the required bearing capacity and the necessary founding depth without any wastage. The steel Vibropile tubes have long life and are withdrawn after each pile formation for repeated use.
The complete range of Vibro equipment includes self-contained walking, rolling, standard-duty and heavy-duty rigs.
All sizes of Vibropile hammer up to the 4-ton model can be used in the hanging leader Vibropile rig, and give the most economical means of extending the usefulness of heavy-duty crawler cranes.
For full technical details ask for leaflet V1 5176.

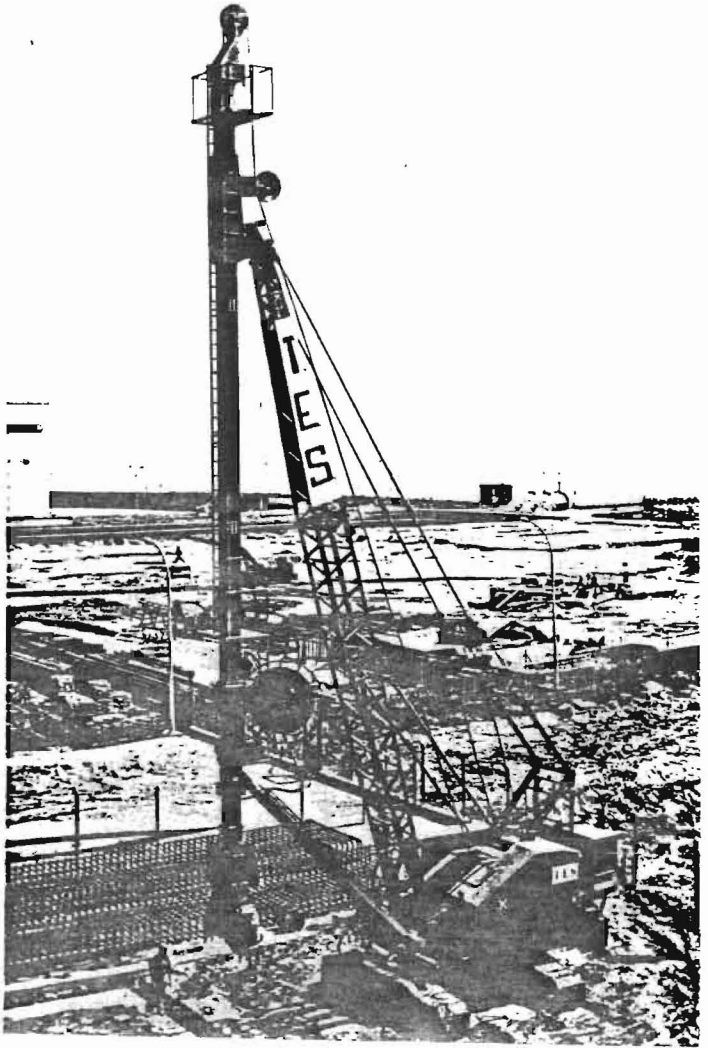


BSP single-acting Vibropile hammers

These are the only hammers suitable for the Vibropile technique of tube extraction. They can also be used for driving all types of tube or prefabricated piles.
The blows are delivered by the main body or ram which is raised by air or steam pressure and then allowed to fall under gravity for driving. The extracting blows are effected by the body being driven upwards and striking the anvils of the extracting links.
A maximum of 50 blows per minute can be achieved with the rapid-action valve. This is easily controlled by a hand line or by an electronic attachment to the manual valve which provides infinitely variable stroke control.
The hammer is located in the mast by claw guides.
For full technical details ask for leaflet.

MODEL	2.5T	3T	4T	5T
Body weight kg	2500	3000	4000	5000
Max energy per blow m kg	3425	4110	5480	6850

The BSP Standard Single Acting Hammers are similar in build but range in size from 2·5T Bodyweight to 15·00 Ton.



BSP Trencha rig and grab for diaphragm wall construction

The Trencha rig achieves production rates of over 100 sq m, panel face area (with average working of 30 cycles per hour) during an eight-hour shift – and all with exact verticality made possible by the adjustable stay and long kelly guide.
The depth of the excavation is much greater than the length of the crane boom because the long kelly bar telescopes through the kelly guide.
Rigs can be attached to most cranes of suitable specification with minimal modifications to the cranes.

The hydraulic power pack, mounted on the rear of the crane, powers both the grab and the telescopic stay.
The grab is designed to ensure maximum digging efficiency without using excessive power or having disproportionate weights. The spoil is discharged instantly from the jaws by patented ejectors.
For full technical details ask for leaflet.

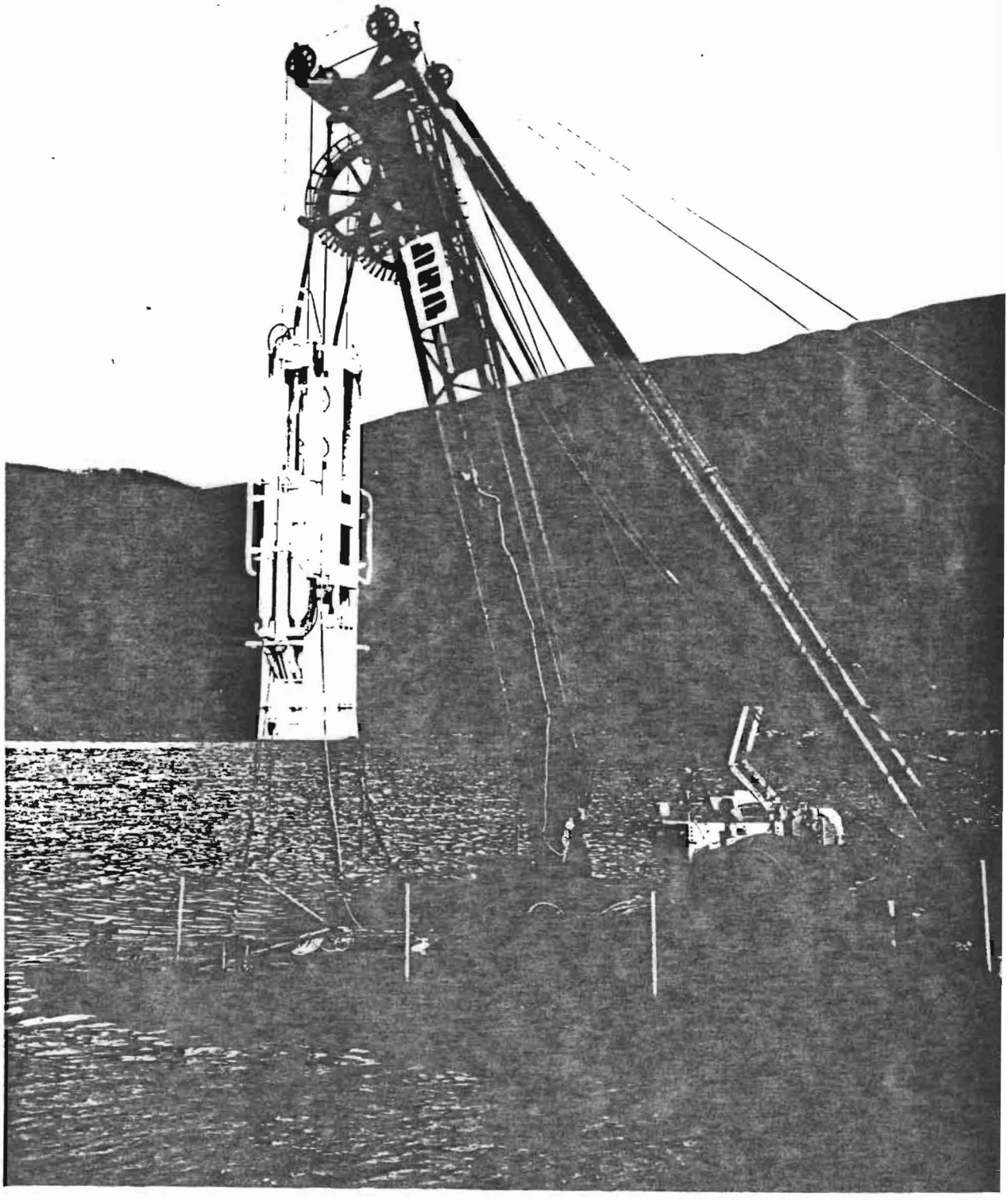
MODEL	T25	T35
Digging depth (m)	25	35
Overall weight mounted in forward position without grab (tonnes)	9	10.5
Pump output (L/min)	150–189	150–189
Average capacity of crane 6.1 m radius (tonnes)	12-14	13-16
Crane single line pull (tonnes)	9-12	10-13

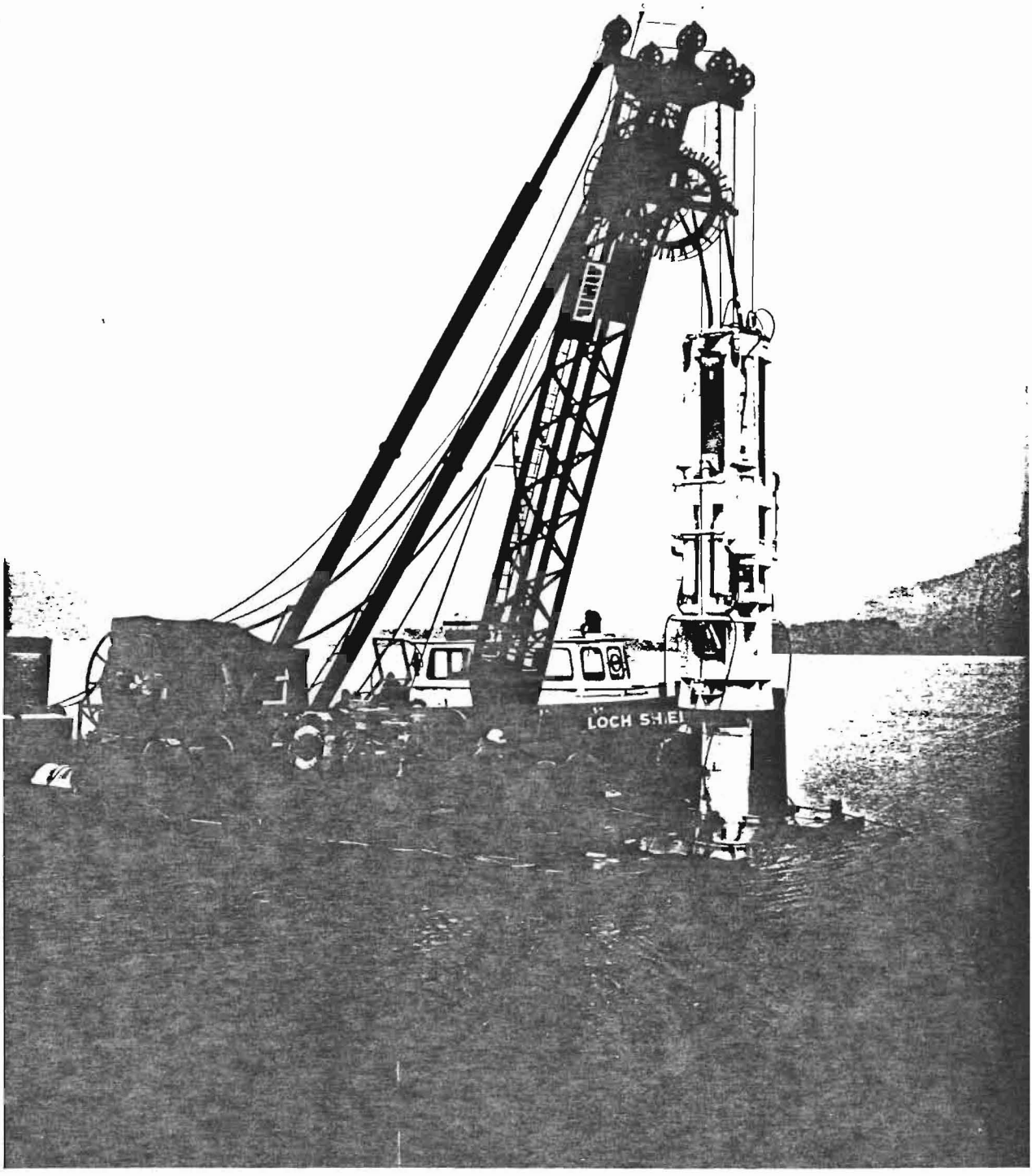
Variations in crane capacity and SLP are relative to grab size

BSP foundation equipment includes:

- Double-acting air pile hammers
- Single-acting air/steam pile hammers
- Double-acting diesel pile hammers
- Single-acting diesel pile hammers
- Piling plants and leaders
- Vibratory pile drivers
- Pile extractors
- Vibro piling system
- Large bore drilling equipment
- Diaphragm walling equipment
- Cased Piles
- Spiral weld steel pipes and pipe piles
- Steel trench sheeting
- Fibertex Filtersheet

BSP INTERNATIONAL FOUNDATIONS LIMITED
Claydon, Ipswich, Suffolk, IP6 0JD, England.
Tel: Ipswich (0473) 830431 Telex: 98115
Telegrams: Pilingdom Ipswich




LOCH SHIEL