ISMA* Technical Conference

Sandefjord, Norway

8-11 September 1970

**In 1982, the name of the International Superphosphate Manufacturers' Associations (ISMA) was changed to International Fertilizer Industry Association (IFA).*

THE PORT HANDLING OF FERTILISERS AND FERTILISER RAW MATERIALS IN SACKS AND BULK

By :

J.H. Bost

Docks Industriels,
Bordeaux,
France.

In the context of the port handling operations, the nature and type of the material play a considerably less important part than its conditioning, i.e. whether in bulk or in packs (sacks, crates, etc.).

For this reason we shall discuss the handling techniques in use at French ports for both imports and exports, in terms of these two main classes of merchandise, in bulk or in packs, the latter, in the case of fertilisers, meaning bags.

1. THE HANDLING OF BULK MATERIAL

a) Imports

French ports receive, by sea, raw materials and some manufactured fertilisers.

The imported raw materials, in order of importance, are phosphates, sulphur, pyrites, and latterly, potassium salts.

We shall deal, first, with the handling of phosphates, since by virtue of the tonnage they represent for French ports (more than 2 million tons), it is in this sector that the methods of handling and delivery have undergone most improvements in recent years.

Until the 1960's the delivery of phosphates to French ports was carried out be vessels of medium tonnage (2,000 to 6,000 tonnes on average).

These relatively modest shipments correspond, on the one hand to the storage capacity of the factories, and on the other to the vessels available on the fairly short runs to and from the main sources of supply (Morocco and Tunisia) for the French chemical industry.

These vessels were and still are unloaded, since this traffic still goes on, at wharves that are usually publicly owned, but sometimes privately owned, by means of cranes from 4 to 6 tonnes capacity, equipped with grabs.

Unloading by buckets, necessitating large gangs of dockers in the holds, armed with shovels to fill the scoops, was used only in some small ports, and had practically disappeared by 1950.

The cargoes of these medium-tonnage vessels, when unloaded at public wharves is put on lorries, if the factory is situated within the port zone or its immediate vicinity, and on railway wagons if the factory is inland.

It should be mentioned that this method of handling is still largely used at ports such as Dunkirk, Rouen, Nantes, Bordeaux and Sète.

The rates of unloading are somewhat limited and very variable. They are limited for two reasons, firstly because unloading operations have to stop when a crane is moved from one lorry to the next, or from one line of railway trucks to another, and also because the cranes installed on the public wharves, as we stated earlier, do not in the main exceed 5 to 6 tonnes capacity. Such cranes were adopted by the port authorities to enable them to handle goods in bulk as well as in packs.

The rates of unloading vary for two reasons. In the first place, ships with a cargo made up of several consignments are dealt with less quickly than those having a single cargo. In the second place, and this is particularly important, it is difficult for a cargo of 2,000 to 6,000 tonnes to find a vessel of the self-trimmer or easy-trimmer type. The charterers are, thus, obliged to make frequent use of vessels from the regular shipping lines. Such vessels have tweendecks that create problems during unloading since the cranes cannot reach directly into all parts of the hold.

Nevertheless, for this type of operation, we can take as an average figure, subject to the variations outlined above, a rate of unloading of 70 tonnes per hour, per crane.

It should be added that some French factories, situated at ports, have had their own wharves since before the war.

In such cases the rates achieved for similar types of cargo are in general higher than the figure that has been quoted above, since the off-loading of phosphate usually takes place not into lorries or ordinary railway wagons, but onto conveyor belts, or in certain circumstances into railway hopper wagons belonging to the factory.

Clearly, it is this continuous off-loading that gives rise to the increased rates of discharge.

As examples of private wharves taking in phosphates on conveyor belts linked to the factory, we may instance the installations of La BORDELAISE des Produits Chimiques at Nantes, which were erected well before the last war, and of much more recent date, those of La Société PECHINEY-SAINT GOBAIN at Rouen, and of La Société SOCADOUR at Bayonne.

However, still on the subject of unloading of medium-tonnage cargoes, a major technical advance came about from the time of the 1950's with the use in the holds of mechanical shovels, known generally as dumpers. These belong to the dock companies, or to the factories in the few cases where they, themselves carry out the unloading. One of the factors that substantially increases the costs of handling phosphates and in general of goods in bulk, is the cleaning out of the base of the hold. At this point the automatic grabs can no longer be filled to capacity, and furthermore, in the case of the vessel fitted with tweendecks, the grab cannot get at all parts of the hold.

Thus, until the 1950's, the stevedoring companies were obliged to employ dockers, often in large numbers, to pile with shovels the phosphate beneath the hatches, so as to provide sufficient to fill the grab. This procedure was costly and its efficiency varied with that of the dockers.

The adoption of self-propelled mechanical shovels, of compact size and small turning circle, has brought about a reduction in the cost of this operation, and above all, an improvement in the average rate of unloading the vessels.

The handling of phosphate has seen rapid changes over the last few years, and these are still far from being complete. This has led to a review, not only of the handling methods, but also of the infrastructure of the ports.

The cause has to be sought in the considerable increase over recent years in size of the vessels used to transport goods in bulk, from 5,000/10,000 tonnes to 20,000 tonnes, then to 50,000 tonnes, and now in some cases 100,000 tonnes.

The object of this technical advance is the reduction of transport costs, and also became necessary because the sources of supply of phosphate are now widely scattered, and the new deposits are, in many instances, large distances away from French ports (e.g. U.S.A., West Coast of Africa). This necessitates the use of vessels of large tonnage.

To illustrate this point, we can state that, in 1968, of the 32 million tonnes of phosphate transported by sea throughout the world, 12,300,000 tonnes, or 35.5%, were carried in specially-equipped bulk-carriers of large tonnage. In tonne-miles, the share of these specialised bulk-carriers jumped from 28% in 1967 to 47% in 1968, which is an indication of the increased distances that are having to be covered.

This increase in the size of ships and in the individual tonnages to be off-loaded has brought about the following effects :

- on the one hand, the number of ports capable of taking such vessels is limited owing to their draught, and even their length where the port is on a river.

- on the other hand, the size of the cargoes means that, sometimes, they have to be made up of groups of consignments, and consequently it is not possible to off-load them straight into the factory. This has entailed the setting up of intermediate storage points at the ports. These storage points would seem, furthermore, to be a necessity in the case of these large vessels in order to allow the requisite rates of unloading to be maintained.

Currently, the position at those ports mainly concerned with the shipment of phosphates is as follows :

DUNKIRK can handle vessels of about 50,000 tonnes, and in a few months' time up to 110,000 tonnes.

ROUEN, vessels from 17,000 to 25,000 tonnes, at least at the private wharf of la SOCIETE PECHINEY-SAINT GOBAIN where the gantry frame equipment can handle 10,000/12,000 tonnes per day.

NANTES is at present limited to vessels of 8,000 tonnes, but a proposed new wharf between St. Nazaire and Nantes will be able to take vessels of more than 20,000 tonnes.

BORDEAUX can take vessels from 20,000 to 25,000 tonnes.

SETE, currently vessels from 10,000 to 12,000 tonnes, but a new wharf, due for completion in some months' time, will handle vessels from at least 20,000 tonnes. It is planned to instal a phosphate silo at this new wharf.

As part of these new installations, silos of various sizes are being currently erected near to the deep-water wharves to which they are linked by conveyor belts. The silos are equipped for the despatch of phosphates, on railway wagons or lorries, and, in some cases, by inland waterway transport.

The first silo of this type was built at Sète. It consists of a store of 18,000 tonnes capacity, having a roof that can be opened through which the ships' derricks discharge the cargoes directly. It has been financed by a private company in conjunction with the local Chamber of Commerce, and it is used exclusively for cargoes destined for that company.

At Bordeaux, four vertical silos with a total capacity in the region of 24,000 tonnes have also been constructed, by a private receiver for his own use, in the immediate vicinity of a new deep-water wharf constructed by the Harbour Board and used not only for phosphates, but for other bulk traffic such as iron ore, and potassium salts (Figures 1, 2 and 3).

In order to enable this wharf to handle vessels up to 25,000 tonnes, it is equipped with two 15 tonne and two 6 tonne cranes, as well as a conveyor belt linking the wharf to the silos. The throughput currently achieved is of the order of 500/600 tonnes per hour, i.e. about 9,000 tonnes in 16 working hours.

The latest installation came into service only two months ago, at Dunkirk. It comprises five vertical silos each holding about 15,000 tonnes, i.e. 75,000 tonnes in total.

The silos have been constructed by the Dunkirk Harbour Board, with the financial backing of a private Company, la Société Maritime de Gestion et de Transport, which will be responsible for running the installation. In contrast to the two examples quoted previously, these were not built by a company concerned with the import and use of phosphates.

The silos are connected to the wharf by conveyor belts to facilitate the loading of railway wagons or large-capacity lighters (Figures 4, 5, 6, 7, 8 and 9).

The rates of loading are particularly interesting, 600 tonnes per hour for hopper wagons and 800 tonnes per hour for lighters.

In the case of incoming vessels with phosphates for transfer to the silos, three cranes of the type known as "Kangaroo", i.e. having a built-in hopper, feed the conveyors to the silos at a rate, which on average looks to be about 6,000 tonnes per 8 hour day. A large ore-carrier (at present this wharf can handle vessels of 50,000 tonnes, and by the end of the year, 110,000 tonnes), can be unloaded at a rate of 18,000 tonnes in 24 hours.

Besides phosphates, French ports take in cargoes of sulphur, pyrites, and some fertilisers in bulk.

In latter years trade in pyrites has declined sharply. This material now comes in from Spain in vessels of 3,000 to 5,000 tonnes, or from Cyprus in 6/10,000 tonners, in the latter case mainly to Dunkirk.

There are no privately owned installations at French ports for off-loading pyrites, and consequently it is unloaded, either at public wharves, or at those of factories that are used also for phosphates.

Sulphur comes in under the same conditions as pyrites, but the individual cargoes are much larger, in the region of 5,000 to 10,000 tonnes. Certain vessels of very large tonnage (20,000 to 25,000 tonnes) discharge part of their cargo at one port (Rotterdam for example), and the rest at a French port such as Le Hâvre or Rouen.

The port of Rouen has received cargoes of 15,000 tonnes in this manner.

The developments in the transport of liquid sulphur seem likely to threaten some reduction in the volume of this trade during the years to come.

We have seen for some time the relatively recent development of an import trade in fertiliser in bulk.

This can be, either nitrogenous, or even, compound fertiliser being sent from one factory to another, possibly in the same Group or not. In this case the traffic is usually carried in vessels of small tonnage of the order of 1,000 to 2,000 tonnes. The unloading is done either at public wharves or at the factory wharf, in either case by cranes equipped with automatic scoops.

For some time we have also been seeing some imports of foreign fertilisers in bulk, but in circumstances differing from the case mentioned above.

Vessels of between 2,000 and 5,000 tonnes are chartered by import merchants who stock the fertilisers in port warehouses, and undertake the bagging of them as and when they have been sold.

As regards port handling, these vessels are dealt with at public wharves situated as near as possible to the warehouses.

New maritime trade that seems certain to grow is that in potassium salts.

Already potassium salts (either sulphate or muriate), from Italy and Spain, have been imported in cargoes of medium size for several years through certain French ports such as Bordeaux and Sète.

The opening-up by l'ENTREPRISE MINIERE & CHIMIQUE (formerly POTASSES D'ALSACE), of an important deposit in Congo-

Brazzaville should lead, according to first forecasts, to the import via the port of Bordeaux of an estimated annual tonnage of 180,000.

These potash materials will be shipped in vessels of 20,000 tonnes which will discharge their cargoes at a phosphate terminal of the type we described earlier.

After being unloaded by conveyor belts, the potassium salts will be stored in the open under sheeting, pending their re-forwarding not only to the factories in the Bordeaux area, but also to Bayonne, La Pallice and Toulouse by railway wagon, lorry, or in some cases by coasting vessels.

The rates of unloading should be similar to those already quoted for phosphates, i.e. of the order of 8,000 to 9,000 tonnes per 16 working hours.

b) Exports

France exports sulphur through the port of Bayonne where la Société Nationale des Pétroles d'Aquitaine has a private wharf equipped with special appliances (mechanical shovel for withdrawing from stock and mobile conveyor belts for the actual loading operation).

This trade is of the order of 1 million tonnes per annum, and the effective capacity of the installation amounts to 1,000 tonnes per hour.

Besides this sizeable traffic, mention can be made of some export of fertilisers in bulk, which is very limited in quantity and irregular in frequency.

It consists for the most part of cargoes of the order of 1,000 to 2,000 tons and is very often the interfactory traffic we spoke of earlier.

The unloading operations take place either at the factory wharf or at a public wharf, using cranes fitted with automatic scoops.

2. THE HANDLING OF MERCHANDISE IN SACKS

These operations are concerned solely with fertilisers, either nitrogenous or compound (binaries or ternaries).

The traffic consists essentially of the export of fertilisers, and until recent years was confined, solely, to nitrogenous types.

In the years 1960/1965, the export of nitrogenous fertilisers was carried on almost exclusively by the COMPTOIR FRANCAIS DE L'AZOTE, and ultimately exceeded 1 million tonnes.

The port handling of these exports is effected by two different methods operating side by side, viz., on the one hand, the loading of factory-packed sacks of fertiliser, after conveyance in railway wagons and transfer direct from thence to the ship, and on the other hand the despatch from the factory of entire trainloads of bulk fertiliser for storage in handlers' rented port warehouses for packing into sacks when the vessels are ready to be loaded.

Since in certain instances storage needs can be of the order of 30,000 tonnes, considerable storage space has been reserved for this traffic in the ports of Dunkirk, La Pallice, Bordeaux, and Sète, by the wharfingers who act on behalf of the COMPTOIR FRANCAIS DE L'AZOTE.

Lines for filling sacks at a rate in excess of 1,000 tonnes per day have been installed by these wharfingers in the warehouses in question.

Regarding the nature of the package itself, this consists, generally, of a jute sack, with a plastic liner when used for urea or ammonium nitrates.

This traffic has declined in recent years, as the factories are making less and less use of the storage and packing facilities at the ports, preferring instead to despatch the fertiliser, ready-bagged, by the trainload when the vessel is ready for loading.

In this connection, it should be mentioned that over the last two years, regular exports of compound fertilisers, packed in plastic sacks, have been made under the aegis of COMPLEXPORT, which is an organisation set up by French producers.

After bagging, the transhipment from railway wagons or warehouse has been carried out, up to the present, in the traditional manner, i.e. unloading of the wagons, or withdrawal from the warehouses, loading on to slings at 1,200 to 1,800 kg at a time, hoisting the slings from the wharf by crane, and then stowing the sacks on board by dockers.

At each port the number of dockers per gang is rigidly fixed for each class of merchandise, although the figure varies widely from port to port, ranging from 19 men at Dunkirk and Sète, to 25 at La Pallice, as against 23 at Bordeaux.

Although the material to be handled is identical, the rates of unloading are similarly very variable, and reflect, unfortunately, the customary practices in each port :

400 tonnes in 8 working hours at La Pallice

360 tonnes " " " at Dunkirk

250 tonnes about " " at Sète and Bordeaux

As a result of this state of affairs, prime costs and, consequently, handling costs differ widely, and this does nothing to ease the exporting problems facing the producers.

Therefore, it seemed desirable to look for an alternative means of handling that would offer lower and more uniform costs.

This could be brought about only be mechanisation, and special loading equipment has been developed abroad, notably, by the firm of FORDETECHNIK.

The principle is as follows :

A conveyor belt leads from the packing shed, which must, therefore, directly face the loading wharf, to a gantry, similar to that of a crane, which is situated on the edge of the wharf. On this gantry is fixed a second conveyor, supported by a movable jib of sufficient span to enable the jib to overhang the ship's hold. At the end of the jib is a chute down which the sacks slide directly into the bottom of the hold, where they fall on to a horizontal, telescopic roller conveyor, which can be swung round to enable the sacks to be conveyed to any part of the hold where they are to be stowed. At the end of the roller conveyor, 2 or 3 men are stationed, who usually work in relays on account of the fast rate at which the sacks come down. Their job is to direct the sacks so that they drop at the requisite spot.

Rates of 500 to 800 tonnes per 8 working hours per machine are attainable, and the number of men in the hold (irrespective of those needed to operate the machinery), should not exceed, as a general rule, 5 operatives.

This equipment came into service this year for the first time in France, at the new factory of la SOCIETE NORMANDE DE L'AZOTE at Le Hâvre, but it has already been in use for several years at Rotterdam and Antwerp.

Clearly, the operating costs are far lower since the labour force is much less, and the output is less dependent on the dockers. Nevertheless, it must be borne in mind that for the successful use of this system, the packing lines must be in premises situated directly opposite the ship. Consequently, this limits its use to factories on a waterfront, such as la SOCIETE NORMANDE DE L'AZOTE at Le Havre, B.A.S.F. at Antwerp or to large bulk fertiliser warehouses situated on the wharfside (as at Rotterdam). On the other hand, it is absolutely impossible, given the nature of this equipment and the output to be obtained, to use this system for the loading of sacks of fertilisers which leave the factory in railway wagons for direct transhipment to vessels. In this case, the traditional method of handling is the only one possible.

Similarly, we may instance by way of interest, the occasional import, in vessels of 1,000/3,000 tonnes, of fertilisers in sacks. These are discharged in the traditional manner, using cranes and dockers, and are either cleared immediately onto lorries or railway trucks, or else stored in the port warehouses.

* * * * *

EQUIPMENT FOR HANDLING PHOSPHATES

COMMERCIAL CONSIDERATIONS

LOCATION

The phosphate wharf is situated at the south end of No. 2 Dock

Layout behind the wharf (apron) :

- permanent way for cranes, spanning two railway tracks.
- conveyor belt T1 parallel to the dockside.
- the apron proper.
- the service road of 10.5 metres width.
- railway tracks for the loading of phosphate trains.
- silos for phosphate.

PRODUCTS THAT CAN BE STORED

- Moroccan phosphate : 75% phosphate, 80% " , Calcined phosphate, 70% phosphate) $1.3 < d < 1.4$; $30^\circ < \phi < 35^\circ$
- African phosphate : $d = 1.35$ $\phi = 29^\circ$
- American phosphate : $1.25 < d < 1.36$

THE EQUIPMENT CAN EFFECT

		at the rate of
- transfer to silo with weighing to 5%	approx. ...	2,000 t/h
- storage " " "	"	2,000 t/h
- withdrawal from stock " "	"	2,000 t/h
- loading into lighters " "	"	1,000 t/h
- loading into wagons " 2%	"	1,000 t/h
- direct transhipment " 5%	"	1,000 t/h
- recycling " "	"	1,000 t/h

This equipment is served, in the 1st phase, by two "Kangaroo" type cranes of 15 tonnes S.W.L. with a maximum throughput of 565 tonnes per hour.

Capacity of the silos : 5, each of 15,000 tonnes (11,600 m^3) of phosphate ($d = 1.30$)
Possible future extension by a further 3 silos.

CONSTRUCTOR : SOCIETE EUROPEENNE DE MANUTENTION CONTINUE.

DETAILS OF CONVEYORS

	T1	T2	T3	T4	T5/5b	T6	T7	T8	T9
Point of Departure	crane	T1	control tower	T3	silo	T5or T5/b	cont. tower	T7	cont. tower
Going to	T2	control tower	T4	silo	T6	cont. tower	T8	lighter loader	railway wagons
H.P. of Motor	220	220	250	2x40	65/35	125	35	75	
Dist.between ends. metres	200	77.25	85.70	72	90/55	85.60	75	85	44
Inclination	Level	upward	upward	Level rever-sible	Level	up-ward	down-ward	Level	Level
Rise/Fall Metres	0	16	24.65	0	0	21.40	8.50	4.50	0
Belt speed Mtrs/sec.	3.5	3.5	3.5	3.5	3	3	3	3	3
Throughput Tonnes/hr	2,000	2,000	2,000	2,000	1,000	1,000	1,000	1,000	1,000
Belt width Metres	1.2	1.2	1.2	1.2	1	1	1	1	1

LOADING OF LIGHTERS

The machine is capable of loading lighters of 280, 320 or 350 tonnes and strings of lighters up to 2,500 tonnes.

DETAILS OF THE MACHINE

- throughput	1,000 tonnes/hr
- guage of permanent way	10.65 metres
- length of jib beyond the quay	9 metres
- maximum inclination of the jib when stationary	+ 80°
- speed of lateral movement	20 metres/Min
- headroom under gantry	4.80 metres
- headroom under jib	4.50 metres

LOADING OF RAILWAY WAGONS (hopper wagons from 40 to 60 tonnes at the rate of 1,000 tonnes/hr)

The operation of this equipment is semi-automatic, and depends on the size of the wagons.

The weighing operation is carried out on two weighbridges (100 tonnes and 80 tonnes), working either singly, or in tandem.

CONTROL AND WEIGHING TOWER

This installation comprises two weighing devices, one on conveyor T2 going to the storage facilities, and the other on conveyor T6 which is used for loading lighters.

DISCUSSION

Mr. J.H. BOST (Ugine-Kuhlmann, France) : I would first point out that this paper is confined to materials handling operations in French ports, but as you have perhaps noticed, some of the observations are applicable to the conduct of these operations in ports wherever they may be situated, and also to goods other than fertilisers and the raw materials of the chemical industry. Indeed in the sphere of the handling of materials in ports, the nature and the type of the material play a far less important role than the form in which it arrives, i.e., whether in bulk or in packages, the latter in the case of fertilisers being a sack. It is for this reason that, in my paper, I have looked at the techniques of materials handling in French ports in the context of these two main classes of merchandise, in bulk and in sacks.

In the case of materials in bulk, French ports receive by sea raw materials and a relatively much smaller quantity of manufactured fertiliser. The imported raw materials, in order of importance, are phosphate ores which easily occupy the first place, sulphur, pyrites, and latterly potassium salts, either chloride or small quantities of sulphate. I shall deal first with the handling of phosphates, since by reason of the tonnage they represent for French ports, of the order of 2 million tonnes in 1970, it is with this commodity that the methods of handling and delivery have undergone most improvements in recent years. In my paper I have quoted the figure of 32 million tonnes for the phosphates transported by sea throughout the world in 1968. This is clearly lower than that for certain other bulk traffic such as iron ore, but it is nevertheless still an appreciable figure.

Until the 1960's phosphates were delivered to French ports in vessels of medium tonnage (2,000-6,000 tonnes on average). These relatively modest shipments corresponded, on the one hand, to the storage capacities at the factories, and on the other to the vessels that were available on the fairly short runs to and from the main sources of supply for the French chemical industry, i.e., Morocco and Tunisia. These vessels were, and still are, unloaded at wharves most of which are publicly owned, but some are in private hands, by means of cranes of 4-6 tonnes capacity, equipped with grabs. We can take as an average figure, subject to the variations outlined above, a rate of unloading of 70 tonnes per hour per crane. This average is based on the complete unloading of the vessel, since at the beginning of the operation the figure is above the average, and drops towards the end because of the need for clearing out the hold. It should be added that some French factories situated in ports already had their own wharves before the last war, and in such cases, even with the equipment then available, they were able to achieve higher rates than those at the public wharves, since, being private installations, their cranes discharged not into lorries or railway wagons, but onto conveyor belts which provide a continuous off-loading operation. However, still on the subject of medium tonnage cargoes, a major technical advance came about in 1950 with the use in the holds of mechanical shovels, generally known as dumpers. These belong to the dock companies, or to the factories where they carry out the unloading. One of the factors that substantially increases the cost of handling phosphates and of bulk materials in general, is the clearing out of the last remnants from the bottom of the hold. When this stage is reached, the automatic grabs can no longer be filled to capacity, and moreover, if the vessel has tweendecks, as in the case of many medium tonners, the grab cannot get at all parts of the hold. Until the 1950's the stevedoring companies often had to use large numbers of dockers with hand shovels, when not only the output but also the operating costs went up. Thus it can be said that the first real improvement was the introduction of the mechanical shovels. These, generally speaking, are of modest capacity, since what is required of a mechanical shovel to be used for clearing out the bottoms of holds is not the ability to move large quantities at a time, a 1,000-1,500 kg dumper would be too big for this purpose, but ease of handling, a small turning circle (since there are many nooks and crannies on a boat), which will enable it to gather together amidships the requisite amounts of material, which are then within range of the crane.

A considerable advance has taken place in the last 10 years in the handling of materials in bulk including, of course, those raw materials with which you are concerned. This advance, which is not yet finished, is bound up with the spectacular increase in the size of ships. This increase in size, whose object is the reduction of transport costs, has reached considerable proportions. I need only mention that an oil tanker of 250,000 tonnes, which is now the usual size, carries the same number of crew as a 20,000 tonne tanker in the 50's. What is true for oil is equally true for cargo vessels, their capacity having risen from 5,000 to 10,000 tonnes (the Liberty ships were 10,000 tonners), to 20,000 then 50,000 tonnes. There are now bulk transporters, mainly for ores, of 100,000 and even 150,000 tonnes. This advance has occurred at the same time as, and it is, I think, a fortunate coincidence for the chemical industry, the sources of supply of phosphate ores became more widely scattered. In many cases the new deposits are situated at great distances from French ports, and this necessitates the use of vessels of large tonnage. To illustrate this point we can state that in 1968 the share, in tonne-miles, of phosphates carried in specialised bulk transporters jumped from 28% in 1967 to 47%, which is an indication of the increased distances that have to be covered. The increase in the size both of ships and of the individual tonnages to be off-loaded has had the following effects ; on the one hand, the number of ports capable of taking such vessels is limited by the draught required, and where the port is on a river sometimes by the length ; on the other hand the size of cargoes means that sometimes, even often, they comprise a number of separate consignments so that it is not possible to off-load them direct into a factory. This has resulted in the establishment of intermediate storage facilities in the ports. In the case of these large vessels such storage facilities would seem to be essential in order to allow the requisite rates of unloading to be maintained with the aid of conveyor belts to provide continuous unloading. On page 4 of my paper you will find details of the off-loading facilities at a number of French ports which take in phosphate. The new installations for the off-loading of phosphate are set out in the following rather schematic manner ; the length of the deep water quay must be at least 200 metres for vessels of 20,000 tonnes and the available depth of water 10-11 metres, 80,000-100,000 tonnes requiring a length of 300 metres and a draught of 13-14 metres ; and cranes each of 13-15 tonnes capacity are needed for discharging into hoppers which feed conveyor belts linking the quay with the silo. I would point out in this connection that, at Dunkirk, which is the most recent port to benefit from an up-to-date installation with facilities for the storage of phosphate in silos, a new design of crane has been adopted. This is called a Kangaroo crane, because it has a built-in hopper situated within the gantry. This appreciably improves the rate of unloading, because a 90° turn is saved on each bucketful. At Dunkirk the silos belong to the Harbour Board, but they are managed by a private company which also deals with the unloading operations, as well as the storage and forwarding. In this particular instance the silos must be able to effect the forwarding of the phosphates by rail, road or lighter, since among its clients there are users of all these means of transport. This also presupposes a multiplicity of loading and weighing facilities.

There is a point here, which, I think, will interest you particularly, and it is moreover a constraint ; the use of silos implies a reduction in the number of different grades of phosphate that can be stored therein. This is fairly straighforward where the silo is privately owned, since there is only one user involved, and he is able to rationalise his purchases. It is more difficult in the case of a public silo serving several users. At Dunkirk, where, as you will see in the paper, there are five containers of 15,000 tonnes each, it is not a practical proposition to take in more than two grades of phosphate, and I will add that one only would be much better still.

Besides phosphates, French ports take in cargoes of sulphur, pyrites and even fertilisers in bulk. The traffic in pyrites has declined sharply. The traffic in sulphur, which is carried sometimes in fairly large vessels of up to 10,000 tonnes, is on the decline as a result of the import of liquid sulphur. These cargoes of sulphur and pyrites are generally unloaded by traditional means, at public or private wharves, on account of the relatively modest size of the individual cargoes. I am going to pass quickly over the import of bulk fertiliser which is rather sporadic and frequently made up of inter-factory traffic (a factory may load, for example, ammonium phosphate or supertriple for another in the same or an associated group).

I shall now turn to the most recent, chronologically speaking, bulk traffic, which in France is beginning to increase in volume, i.e., the traffic in potash. As I have mentioned, potassium salts have already been imported for several years through French ports such as Bordeaux and Sète which are situated in the south. The sulphate comes from Italy or Spain, and the chloride from Israel in medium size cargoes. The opening-up of a deposit at Congo Brazzaville, not far from Pointe Noire, should lead, according to preliminary forecasts, to the import via the port of Bordeaux of an annual tonnage of 180,000. These potash compounds will be shipped in vessels of 20,000 tonnes, this being the maximum that this port can currently handle - otherwise, I think that the cargoes would be much larger - and they will be unloaded at an ore terminal. Still on the subject of goods in bulk, I would point out that, in the export field, France, as you know, ships sulphur through the port of Bayonne.

I now come to goods in sacks. In this field handling operations are confined solely to nitrogenous or compound fertilisers in the form of binaries or tertiaries. In the years 1960/65, the export of nitrogenous fertilisers, which has been carried out almost exclusively by the Comptoir Français de l'Azote, ultimately reached one million tonnes. The handling operations were carried out in the traditional manner, i.e., in sacks brought by the trainload from the factory, or after prior storage in bulk, at port warehouses rented by the wharfingers who also pack the material into sacks. Such traditional handling techniques had the disadvantage of requiring numerous gangs of dockers. Perhaps you are aware that in French ports, and in others, the number of men in each gang is rigidly laid down by local agreements, and the rates of unloading also used to vary widely from port to port due to complicated reasons connected with the Dockers Statute. Consequently it seemed desirable to look for alternative means of unloading that would offer lower and more uniform costs for the loading of sacks.

Some years ago a process was evolved and developed by the firm of Fordtechnik which consists essentially of a conveyor belt leading from the packing shed, which must therefore directly face the loading wharf, to a gantry similar to that of a crane which is situated at the edge of the wharf. On this gantry is fixed a second conveyor supported by a movable jib of sufficient span to enable it to overhang the ship's hold. At the end of the jib is a chute down which the sacks can slide directly into the bottom of the hold, where they fall onto a horizontal roller conveyor which be rotated to enable the sacks to be conveyed to any part of the hold, where they are required for stacking. With everything running smoothly, rates of 600-700 tonnes per 8 working hours, per machine, are attainable using this system. It requires only one gang stationed in the hold at the end of the conveyor. This gang consists of some 4-6 men, whereas as an illustration, the traditional loading process requires a labour force varying from 18-25 men depending on the port. Thus this is a considerable improvement and an installation of this type has just been put into service in France at a new fertiliser factory at Le Havre. However, the use of this equipment imposes certain restrictions. It can be used only where the packing shed is situated on the wharf. Also, on account of the loading speeds involved, it is not possible to use this system for the direct transhipment of sacks from railway wagon to ship.

Mr. O.B. JORGENSEN (Lysaker Kemiske Fabrik, Norway) : Being a chemist, and having had little time in which to familiarise myself with the subject, I will add very little to Mr. BOST's most detailed account. The paper describes fully not only the techniques used formerly for the loading and unloading of ships, but also the newer methods that are being introduced gradually and which embody the most up-to-date applications. I believe that this account provides us with information that will be useful to our own organisations.

By taking examples from the publicly-owned French ports, Mr. BOST shows us how the needs of the shipping interests have developed, and how this has necessitated increasingly shorter loading and unloading times for boats of ever-increasing tonnage. The size of the modern ship means that the fertiliser factories (other than a few very large ones), cannot accommodate them in their own port installations. Thus the ports described here are laid out to serve an increasing number of users, from which it follows that, in addition to their own loading equipment, they must also have warehouses and the facilities for the loading of boats, railway wagons and lorries.

For the unloading of boats, cranes and grabs are used exclusively. This is understandable on account of the flexibility of this arrangement. I, as a novice in this field, would like to ask Mr. BOST if it is possible to envisage other methods of unloading, e.g., pneumatic tubes for phosphate from North Africa, or the use of bucket conveyors.

It would be interesting to learn the capital cost represented by installations such as those described on page 10, and also the quantity of material that must be handled per year to repay the investment.

The handling of materials in sacks presents more difficulties than material in bulk. Mr. BOST has instanced the problems of handling sacks on board ship, and also those due to the disparity in the numbers of dockers required.

These difficulties can to a large extent be smoothed out by the use of mechanical aids. Mr. BOST describes in some detail the systems used for loading sacks (page 9 and the final photograph).

I have had the opportunity of seeing a similar system in a cement factory and I can tell you that it did the job remarkably well and at the same time it treated the sacks very gently.

Can Mr. BOST tell us if this equipment, when reduced to a suitable size, would be effective for smaller boats and ports ?

In the paper no mention is made of either palletised sacks or their handling. The loading of palletised goods is constantly increasing in Norway, not only for export of fertilisers but also for coastal deliveries. It would be very interesting to know the extent to which this system of distribution is used in other countries, and also its possible future developments.

As most of the handling of fertilisers takes place at ports, and as modern fertilisers contain ammonium nitrate, we ought to consider, for the sake of completeness, the safety measures that should be adopted during loading and transport.

<u>Mr. BOST</u> : Regarding the equipment at the ports, it is quite certain that the unloading of material in bulk requires sizeable equipment. It is necessary for the numbers of berths available to be commensurate with the traffic. On this first point, I must say that phosphate boats sometimes have to wait their turn, but mainly when the vessel is destined for a private jetty, as usually these have only one, or at the most two berths. French ports having public berths do not pose serious problems. At the moment however, there is the risk of new problems arising with the specially-equipped wharves such as those at Bordeaux and Dunkirk, and perhaps eventually at Sète, because there we have the case of a privately-owned port with either one or two berths available, but only with the conveyor belt which connects with the silo. In these circumstances there is some risk of a ship having to wait, but, given the rates of unloading, which, for example, at Dunkirk which at present has only three Kangaroo cranes, can reach 18,000 tonnes in 24 hours, the risk will not be very great.

As to the capital costs involved, I am in some difficulty in replying to Mr. JORGENSEN, as I do not have all the information at my disposal. Perhaps those firms represented here who have either specially-equipped wharves or at least their own silos will be able to give us some indication. What I do know is that a crane, not to mention the machine for the actual handling operation, of the Kangaroo type of 15 tonnes capacity will represent a capital outlay of the order of 1,500,000 to 1,700,000 Francs exclusive of the value-added tax.

With reference to the traffic necessary to make the installation pay, the tonnage it seems, can be relatively modest. This is the case at Dunkirk, where the Port of Dunkirk Authority has set up this extensive installation which entirely belongs to them, on the basis of no more than 250,000-300,000 tonnes per year of phosphate traffic, but with a forecast of rather larger increases later. At Bordeaux, the specially-equipped berth, which is not only a terminal for phosphate but also for ores and recently for potash compounds, was set up with the immediate prospects of a traffic of 140,000 tonnes of potash and 140,000 tonnes of ore making a total of 280,000 tonnes. With increased traffic the port of Bordeaux should reach an annual tonnage of 500,000. The tonnages necessary to make an installation such as this pay, do not need to be very large.

I now come to the differences in costs in the case of materials in sacks. Essentially, the advantage of a mechanised system such as that based on the chute, is the lowering and rationalising of costs. Irrespective of the country or the port in which the machine is being used, the cost is more or less equal, since of the net cost, the operating and the writing-down of the equipment will represent at least 70-80%. As to the manpower, this is virtually constant at 4-6 men. In contrast, with the traditional method for handling sacks, there are considerable differences in costs from port to port because, as I have said, the number of dockers required is laid down by locally-negotiated agreements. The output of the dockers, which is the denominator that enables us to work out the cost per tonne, is very variable and depends on the port. At Dunkirk a gang of 19 men will load about 350 tonnes in 8 hours, at Bordeaux a gang of 25 men will barely exceed 250 tonnes. You can see the extent of the differences. I can also tell you, as someone who is concerned with the handling of exports of fertiliser, that the cost for the same customer are Fr. 5 per tonne lower at Sete than at Bordeaux. Consequently standardised handling systems allow some degree of equalisation of costs.

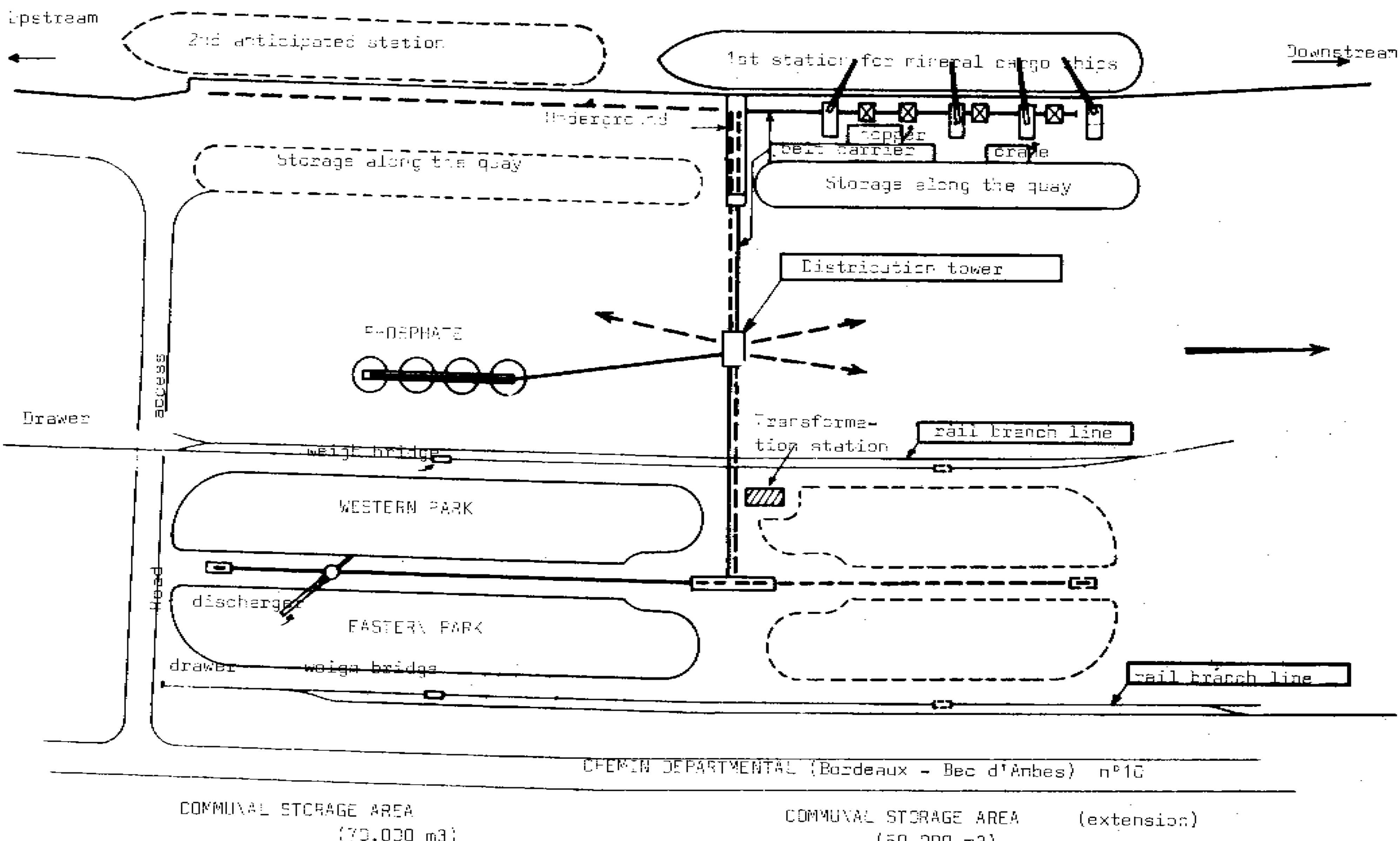
We do use pallets but solely for stowing the sacks on board. We do not leave them there for the simple reason that it would be difficult to make them non-returnable as in the case of the more expensive goods. Economically this is not possible. To leave the pallets on board and ask the consignees to return them is, in theory, possible, but the principal customers of the French producers are China, Pakistan, India and Cuba, and so you will understand that it would be very difficult to get pallets back from countries such as these. Moreover, pallets would be something of a nuisance on a boat of 10,000-15,000 tonnes, since fertilisers, especially nitrogenous fertilisers and now even compounds are being loaded in unit quantities. Therefore, in the case of a vessel of 10,000-15,000 tonnes pallets would represent a considerable waste of cubic capacity.

The last point, the question of safety precautions. These are strictly observed in France. On the one hand there is a regulation in the form of a manual entitled "The transport of dangerous goods by sea", and on the other hand there are the regulations that apply in the ports and which differ from the foregoing regulations covering the conveyance by sea. For example the port regulations lay down in the case of high-grade ammonitrate 33.5%, with which we are primarily concerned, the provision of safety measures including a fire engine standing by. These matters are taken very seriously, but from the manpower point of view, the regulations do not create any problems. However the economic result of these safety precautions is that as soon as the dockers see a fire-engine appear in the port, they immediately demand danger money !

Something that, in economic terms, is of great importance to all chemical factories is material that has become solid. This has happened to us, and it still happens that, when a cargo for unloading has gone solid, the extra charges this involves are often more than double the normal cost of unloading.

Fig. 1

PLAN OF THE HEAVY MATERIAL INSTALLATIONS IN THE PORT AUTONOME OF BORDEAUX



Scale : 1/2 000e

FIG. 2

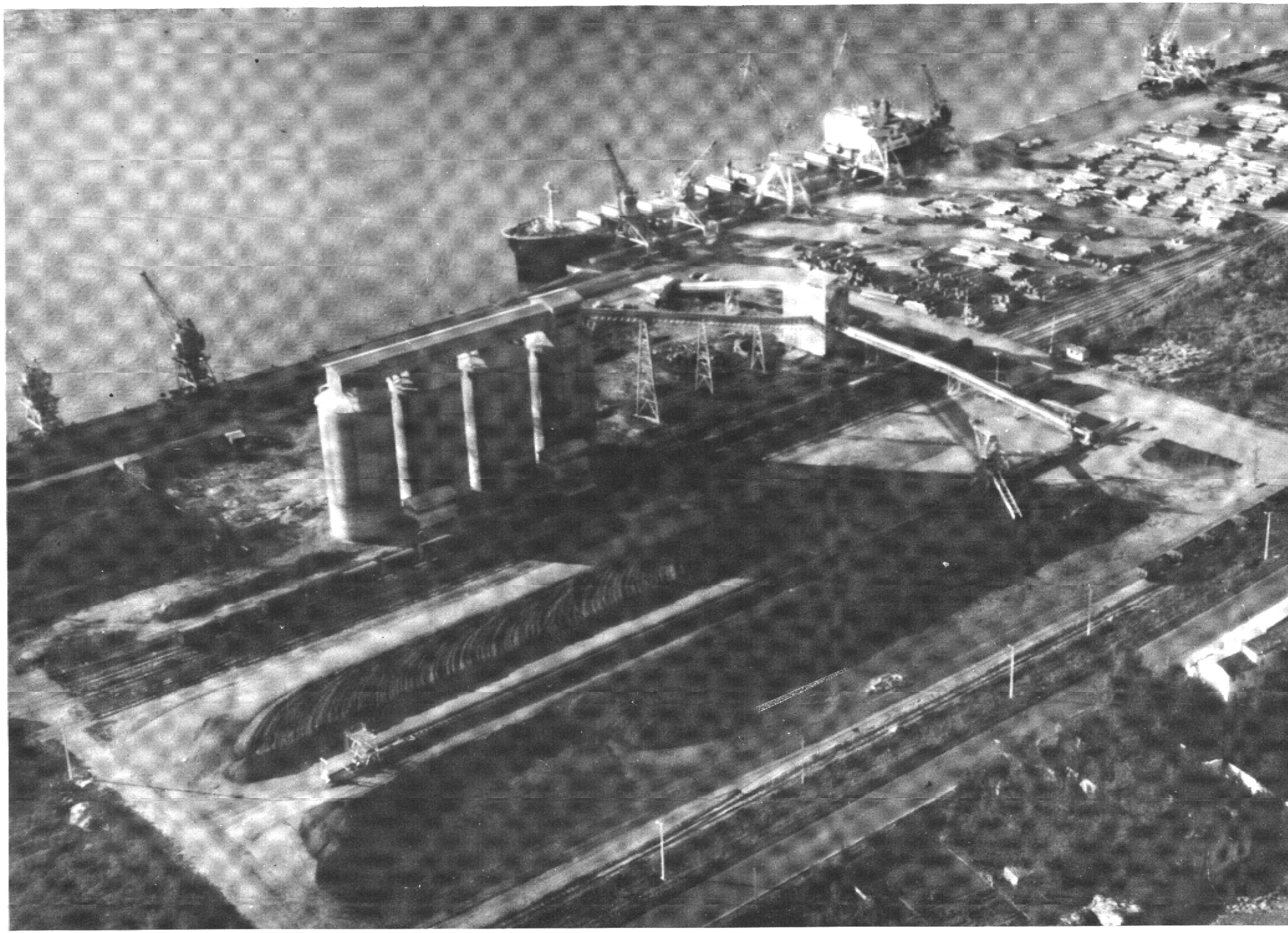


FIG. 3

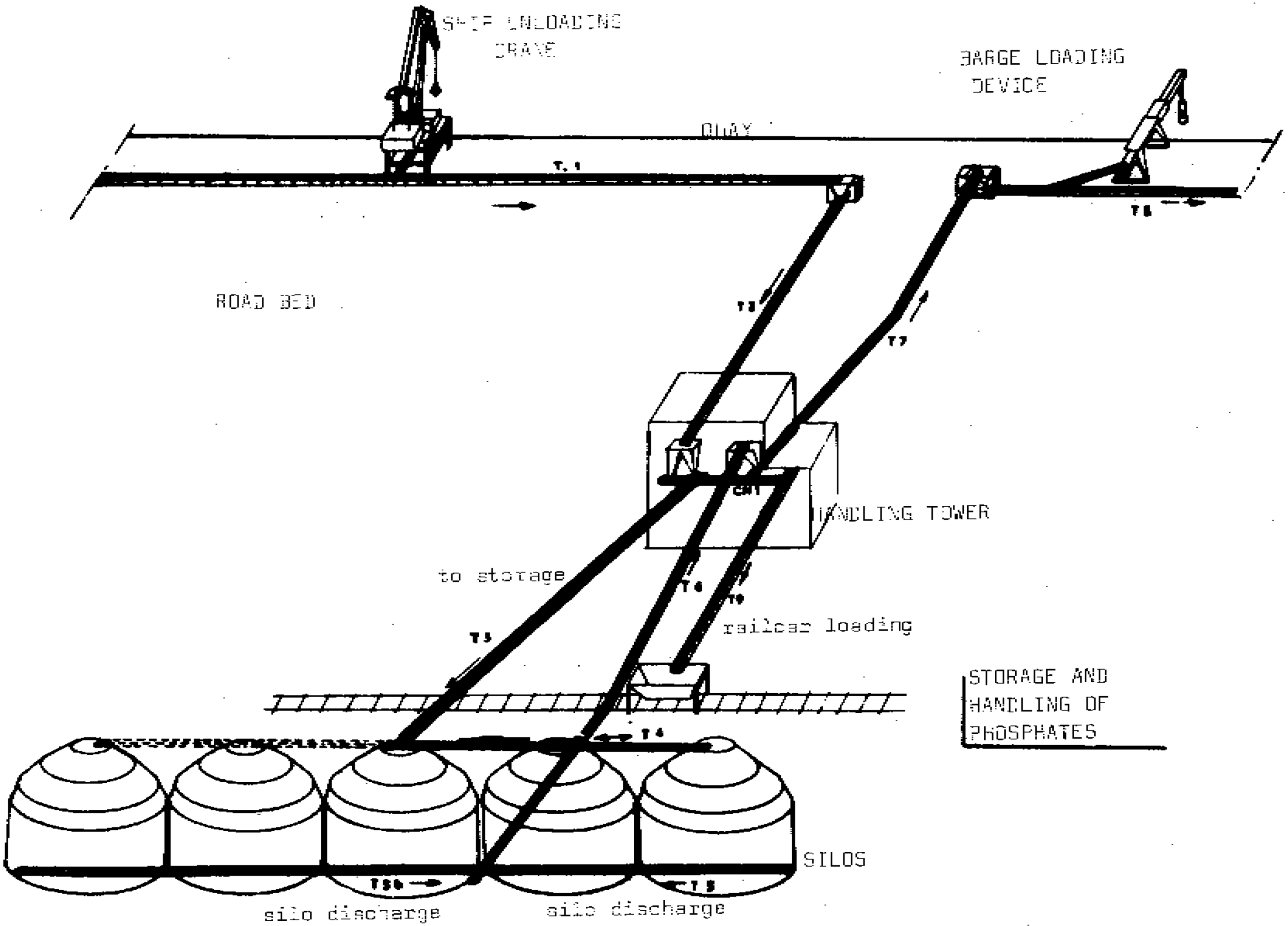
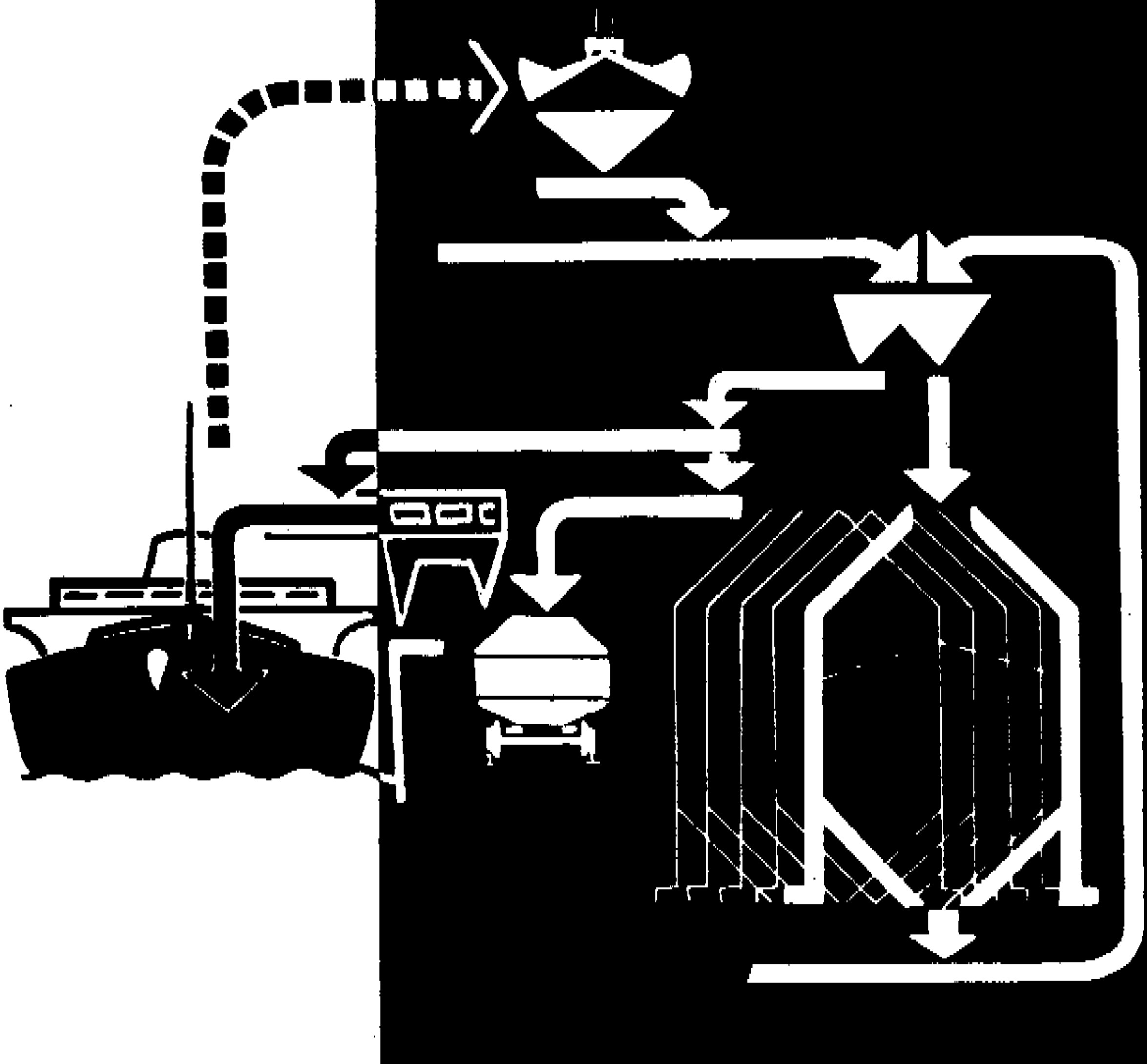

SHIP UNLOADING
CRANE
BARGE LOADING
DEVICE
QUAY
T.1
ROAD BED
T2
T7
T8
HANDLING TOWER
to storage
T6
T9
railcar loading
T3
STORAGE AND
HANDLING OF
PHOSPHATES
T4
SILOS
T5b
T5
silo discharge
silo discharge

Fig. 4.

PAD

PORT AUTONOME DE DUNKERQUE



S.E.S. AVRIL 1969

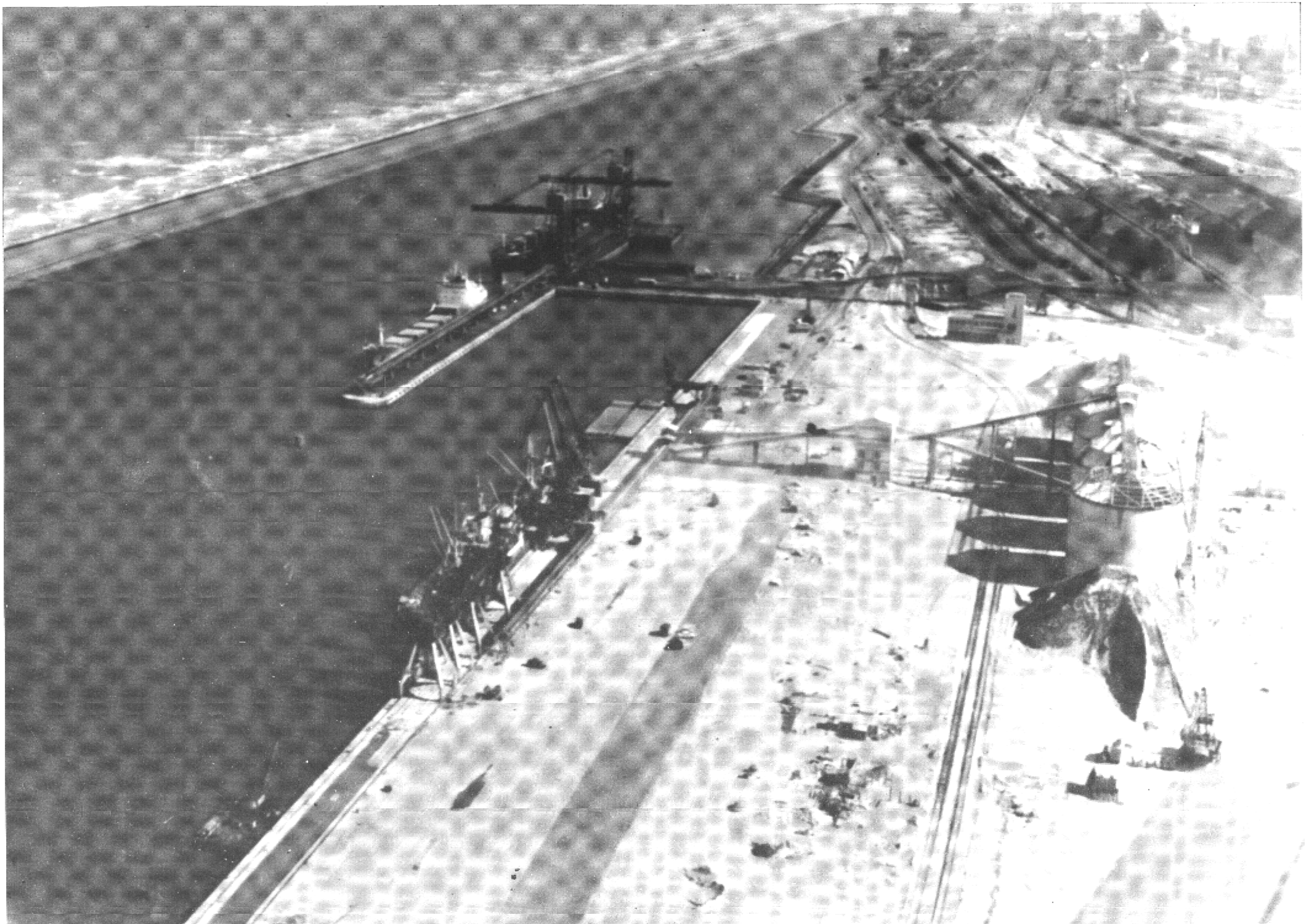


FIG.6

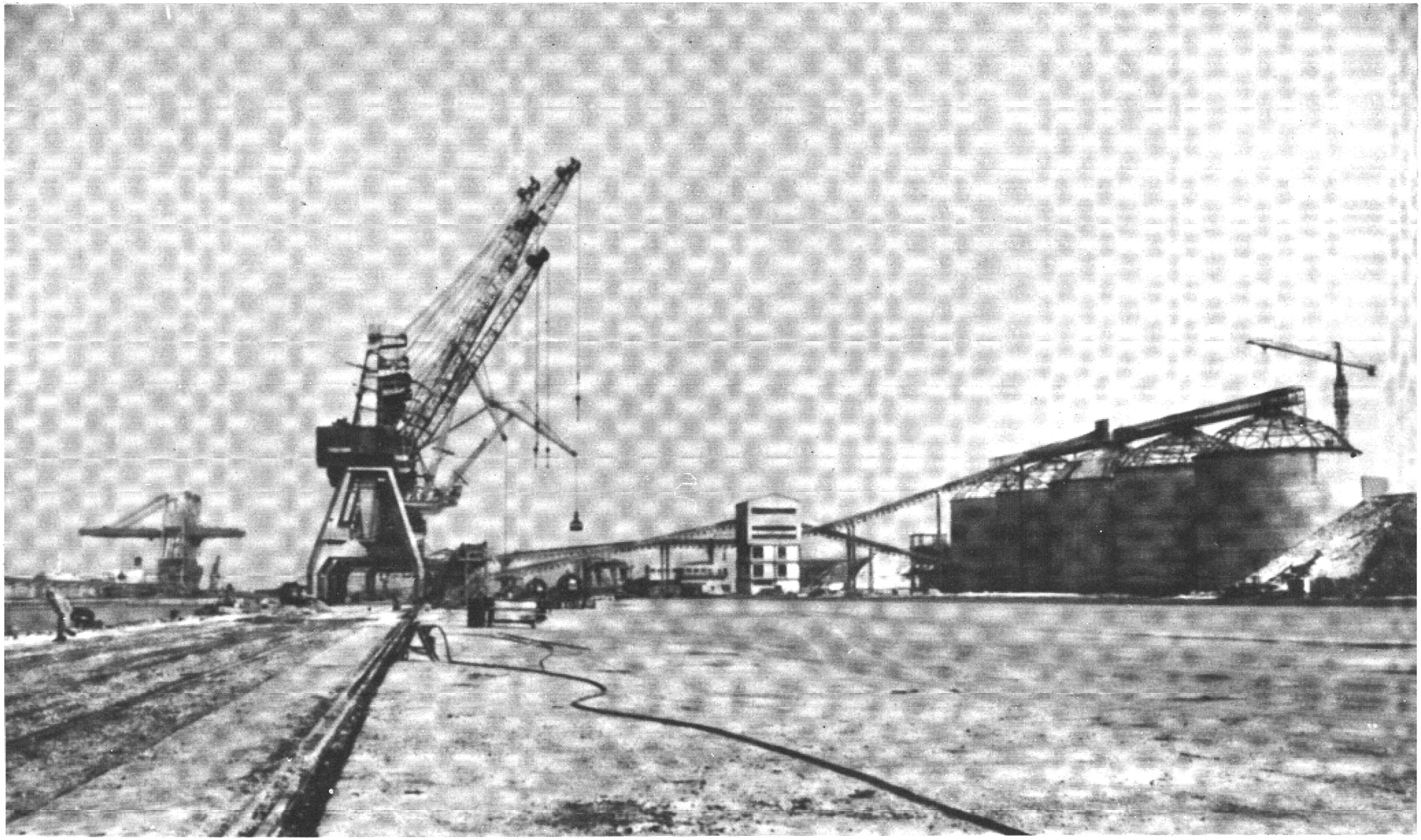


FIG.7

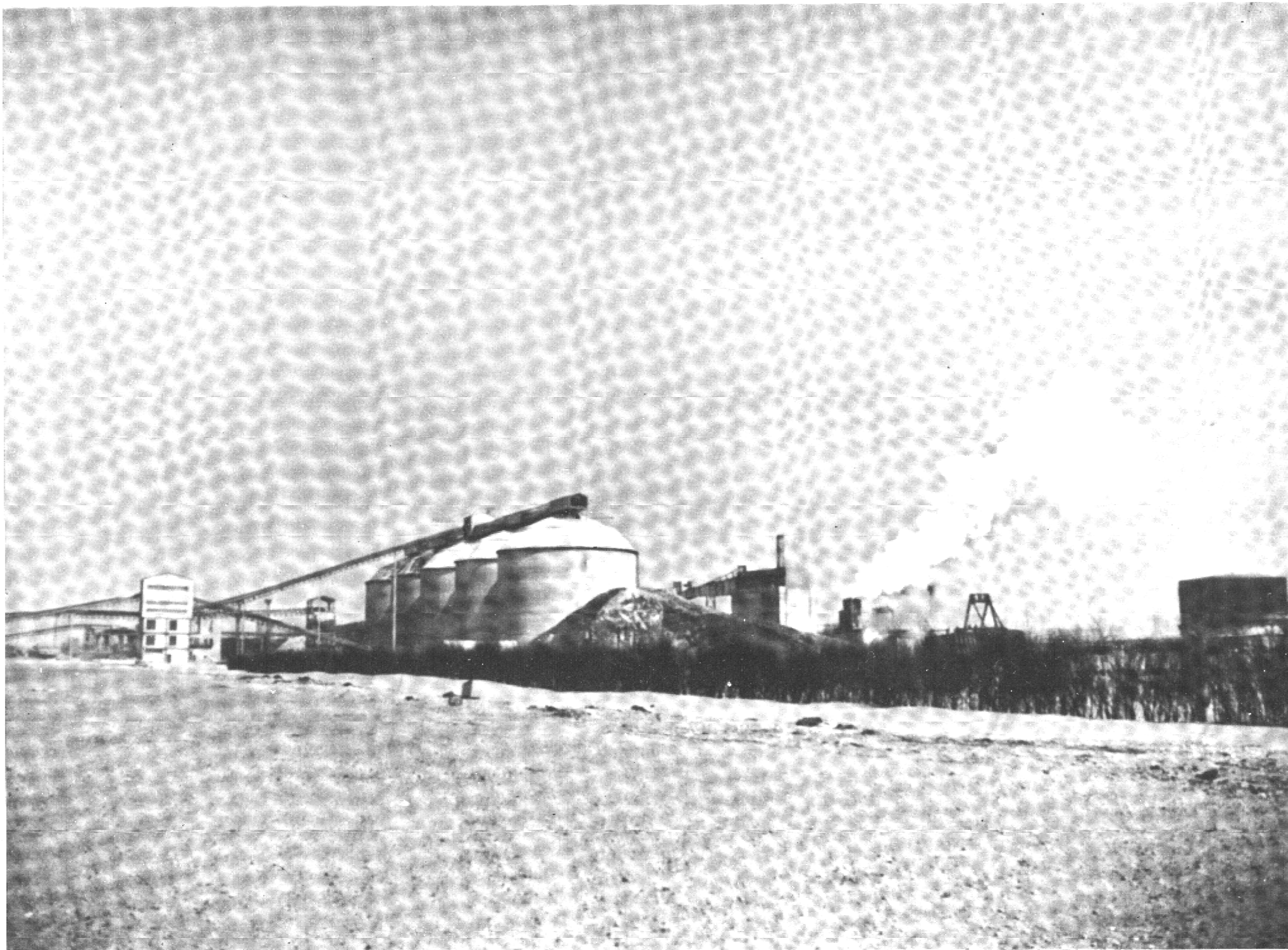


FIG.8

FIG. 9