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CEMENT DEVELOPMENT AND RESEARCH CENTRE

DP/TUR/72/084

TURKEY,

TECHNICAL REPORT:
Conversion of firing systems for use with natural gas

Prepared for the Government of Turkey by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

United Nations Industrial Development Organization

[illegible]

United Nations Development Programme

CEMENT DEVELOPMENT AND RESEARCH CENTRE

DP/TUR/72/034

TURKEY

Technical report: Conversion of firing systems for use with natural gas

Prepared for the Government of Turkey
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

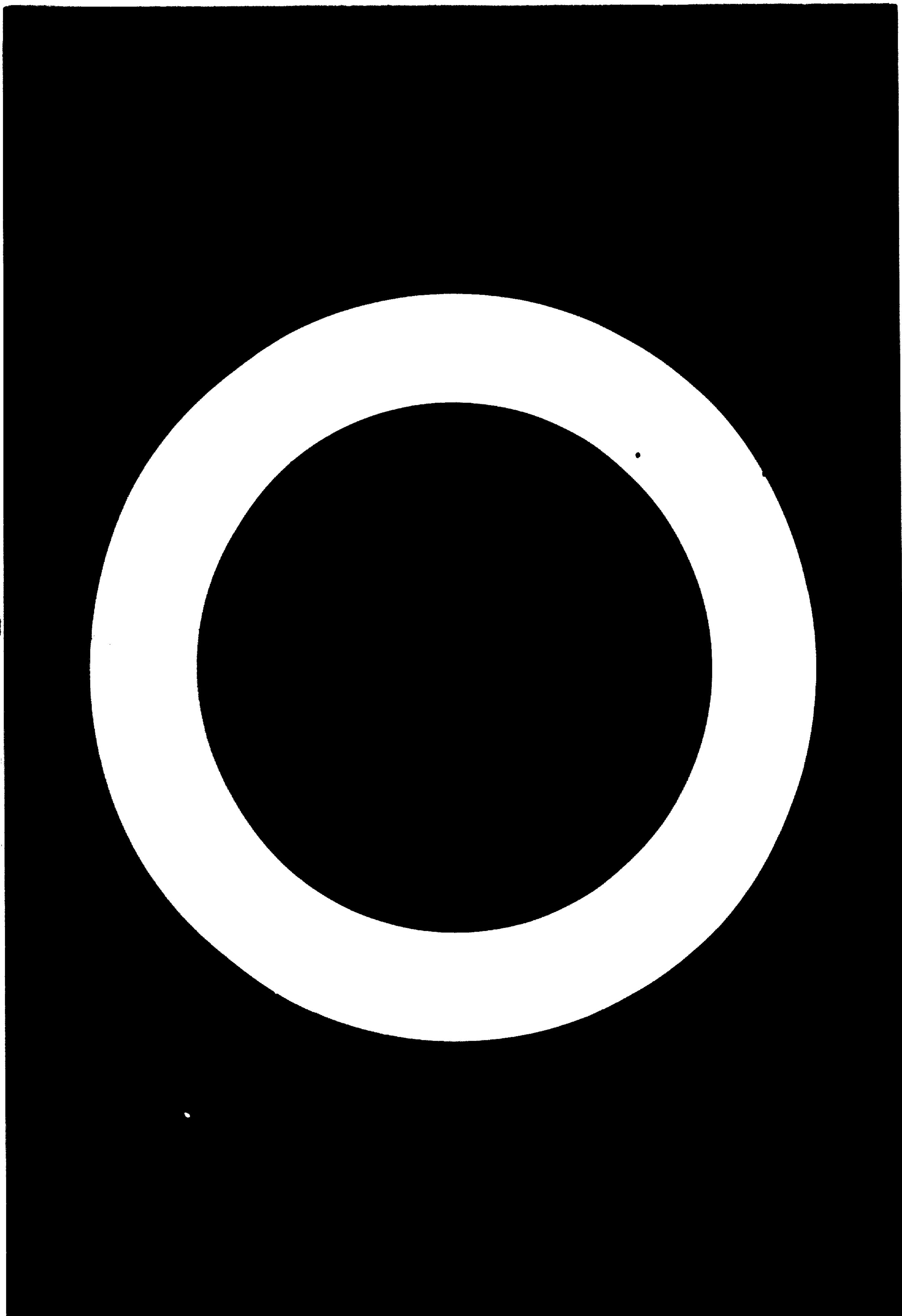
Based on the work of F. Sobek, expert in the conversion of firing systems to use of natural gas

United Nations Industrial Development Organization
Vienna, 1976

ABSTRACT

The technical report on the conversion of firing systems for use with natural gas summarizes the work of an expert sent to Turkey for one month, from 27 September to 25 October 1976, by the United Nations Industrial Development Organization (UNIDO). The mission was part of UNIDO's contribution to a United Nations Development Programme (UNDP) project "Cement Development and Research Centre" (DP/TUR/72/034), for which UNIDO had been appointed executing agency.

The expert had been asked to assist the project manager and Turkish experts in their study of various possible firing systems for natural gas and in planning the conversion of selected factories to natural gas firing. During the mission, his assistance was in fact keyed to the installation of the first natural-gas burner plant in Turkey, at the Pinarhisar cement factory. Discussions were held on initial conditions, the burner suspension, and the equipment required for operation with natural gas and pulverized coal, together or separately. The operating properties and burning characteristics of natural gas were thoroughly discussed with the works management, as were the operating characteristics of the new burner. Particular attention was given to sources of danger when natural gas is burnt without primary air, and ways were suggested to overcome the dangers. The burner shipment was checked against the packing list, and it was arranged that the supplier would be asked to provide a qualified fitter for the assembly of the unit.



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INTRODUCTION

In the course of oil-drilling operations, deposits of natural gas were discovered approximately 30 kilometres south-west of the Pinarhisar cement factory in Turkey. In its request to the United Nations Development Programme (UNDP) for assistance in the project "Cement Development and Research Centre" (DP/TUR/72/034), the Turkish Government had asked for an expert in the conversion of firing systems to use of natural gas. The United Nations Industrial Development Organization (UNIDO), which had been appointed executing agency for the project sent an expert to Turkey for one month, from 27 September to 25 October 1976, to assist in the study of possible firing systems for natural gas and in planning the conversion of selected factories to natural-gas firing. Since the Turkish Government had decided that the first natural-gas burning plant in Turkey was to be at the Pinarhisar cement factory, the expert's assistance was in fact keyed to that installation. The burner chosen for the factory was a Pillard KB 150/3 combined natural-gas/pulverized-coal burner with a nominal output of 24×10^6 kcal/h (approximately 2,500 Nm^3/h of natural gas). It will be fitted to a rotary wet-process cement kiln.

I. FINDINGS

In accordance with the agreement made in Ankara with the managing director of the Pinarhisar factory, the expert ascertained that the shipment from Pillard agreed essentially with the packing lists.

It was not clear whether the air-cooling system provided for the burner shell would be sufficient to ensure that the burner would not have to be moved out of the kiln at standstill. In addition, it was pointed out to the works management that, in case of failure of the current supply, the cooling system would break down and that therefore either adequate insulation of the burner shell or a device for moving the burner shell rapidly out of the port of the kiln would have to be provided.

Although it was not intended to run the plant with pulverized coal firing or with mixed firing of natural gas/pulverized coal in the near future, there appeared to be an urgent need to settle the question of an expedient arrangement to supply the burner with pulverized coal (flexible or rigid supply).

It was also established that the measurement and control section with its main and subsidiary piping and measuring and controlling elements would have to be assembled completely: the piping had been supplied cut to size but not processed further. Since the drawings and diagrams available at the site were not sufficient to permit the installation of the burner without the assistance of a specialist from the supplier, it was recommended that the contractor should be asked to make available an experienced installation foreman or chief erecting engineer for the assembly.

As regards the various suggestions of the manufacturer concerning the suspension of the burner the expert considered that the KB 150/3 suspension was suitable, and he recommended that the management of the plant choose it. (For sketch see annex II.) Since the suspension was supposed to be completed by the time the supplier's fitter arrived, the expert telephoned the supplier and asked for a detailed drawing to be sent. The KB 150/3 suspension with longitudinal, lateral and vertical adjustment has the advantage that the burner slide is suspended on a universal joint very close to the burner hole at the port of the kiln. Since the movement of the burner within the burner hole is small with this arrangement, no sealing problems are caused. It is also important that it should be easy to adjust the exact direction of the flame, particularly with long kilns.

The gas station, which lies 32 kilometres to the south-west of the factory, was built for three rich drill hoses approximately 3,000 metres deep. Daily output is 24,300,000 cubic feet. Static pressure is 4,000 psi and the conduit pressure intake is 300 psi. The station contains the usual equipment, such as a heating plant, dehydrogenation plant and a distribution station, but no odorization plant.

The four-inch pipe line which leads to the plant is laid out as a high pressure pipe line; so after the installation of a reduction station at the works, natural gas can also be supplied from the same pipe line to the kiln under construction.

II. COMMENTARY

General information on gaseous fuel burning

The advantages and disadvantages of burning natural and other gases rather than liquid and solid fuels must be carefully weighed against each other. The most striking advantage of gases over other fuels is their state of aggregation, which is already gaseous, and because gases, particularly natural gas, can also be burnt, by means of special devices, with an incandescent flame. Only the transmission of heat by the radiation of incandescent flames ensures economic operation of a rotary kiln.

The conventional burning of natural gas with oxygen in the form of primary air produces non-luminous blue flames which are undesirable, particularly in a rotary kiln, because of the limited transmission of heat by conduction between lining and material. The transmission of heat by convection is of no great consequence, owing to the short times the hot flue gases stay in the rotary kiln.

Incandescent flames are generated by means of burners which receive little or no primary air as a second medial current. The flames of such burners burn as diffusion flames because they receive all their combustion air from the kiln atmosphere. The shape and the surface of the gas jet can be altered by certain devices which are offered by various manufacturers and which also enable the shape and the length of the flames to be adapted to the particular requirements of the process. The burning of natural gas in such quantities as are required in modern rotary kilns, particularly by means of diffusion flames which are contingent upon the presence of adequate quantities of oxygen in the kiln atmosphere, involves risks which must be anticipated by adequate protective measures (see below).

Reduction of gas pressures and working principles, setting and failures of reduction equipment

The Pinarhisar factory is an exceptional case because the high-pressure reduction plant is situated at a distance of more than 30 kilometres from the works, and the installation thus receives through a conduit natural gas which has already been reduced to 6 bar.

Burning pulverized coal with natural gas, and related principles

The literature concerning the combined natural gas/pulverized coal burner to be used contains almost no descriptions of this combination of burners. The expert therefore wrote to the contractor asking for documentation and in particular for descriptions of combined operations using natural gas and pulverized coal.

Safety principles for gaseous fuel burning

The most important sources of danger are those which exist in spite of current security devices. The two main sources of danger must be emphasized, since the installation is the first natural-gas burning installation constructed in Turkey and it must therefore be assumed that no experience is available in precautions against the occurrence of explosions which can entail personal and material damages.

If a flame-failure control system does not work, after the flame has broken away, more or less large quantities of gases, compared with the fuel supply set, can pass unburnt into the interior of the kiln. The gases sucked in through the kiln into the superposed system by the low pressure can, sooner or later, by making contact with the air from the kiln atmosphere, form oxygen-hydrogen mixtures which will then ignite and explode somewhere in the system. A continuous checking of the parts of the flame-failure control system is therefore the only reliable remedy. A control of the flame by hand is no substitute for a flame-failure control system which does not work, because the times the gases stay in the kiln are far too short in comparison with the reaction time for a manual switch-off. The formation of oxygen-hydrogen mixtures and their subsequent explosion cannot even be prevented by continuous control of the composition of the flue gas at the entrance of the kiln because the control instruments react too slowly to prevent explosions.

The control of the particular stoichiometric combustion ratios required by the process, especially in the rotary kiln, is far more difficult because, although it is possible to measure the fuel supply exactly, it is not possible to measure the quantity of secondary air. A shifting of the combustion ratios in the reduction zone can also cause effects equal or similar to those of flame failure. Particularly with kilns which are operated on two different fuels simultaneously, the supplies of both fuels must be controlled with equal care. The greatest difficulty is caused by the continuous control of the secondary air which must be in a certain minimum ratio to the fuel supply in order to ensure total combustion.

Measurement of the fuel supply. Even if natural gas is required in a plant for one purpose only, it is not sufficient to use the meter of the plant as a basic measuring instrument for the heat supply of the gas-consuming installation. A measurement of the rate of flow, by any suitable means, is essential because the flow meter is used to provide the values for the main throttle aggregate for the regulation of the rate of flow within a fully automatic control system. It is also essential to weigh the pulverized coal before it is fed in, particularly if, as at Pinarhisar, natural gas and pulverized coal are to be used jointly in different ratios, or if the two fuels are to be used separately and alternately.

Control of the quantities of secondary air. During the operation of rotary kilns incomparably greater difficulties are caused by the control of the quantities of secondary air since it is not possible to measure them. The determination of oxygen as part of a gas analysis is not a suitable substitute, because of the inertia factor. For these reasons, auxiliary values and other measured quantities must be used. The pressure of the kiln atmosphere, measured continuously in the port of the kiln and possibly recorded, can be used as an auxiliary value in order to determine that total combustion has been set correctly. If the flame breaks away - which happens rarely - a distinct decrease of pressure, due to the cessation of the combustion expansion, will be noticed. But excessive fuel supply caused by mechanical changes at the discharge system of the burner is also detectable immediately because of a change of the impulse of the flame. It is therefore desirable to install a sensitive pressure measuring instrument with alarm device at this point and to combine it with the quick-action stop valve. A further possibility of controlling the total combustion is provided by the control of the temperature of the flame which decreases considerably if operation is under-stoichiometric. An effective alarm system with a valve can be provided which reacts immediately.

It must be stressed that a change of the fuel/secondary air mixture in the reduction zone (under-stoichiometric zone) will mean that the flue gases of the flames will carry along chemioally combined heat (unburnt components with a frequently high oxygen affinity, including hydrogen gas, which will possibly be subject to explosive after-burning at the entrance of the kiln or within the superposed systems).

Annex I

JOB DESCRIPTION

Post title:	Expert in converting firing systems to use of natural gas
Duration:	One month with possible extension
Date required:	As soon as possible
Duty station:	Ankara with travel in the country
Duties:	The expert will be attached to the Government of Turkey and will in close co-operation with the Project Manager and Turkish experts advise and assist in studying alternative firing systems for natural gas and in planning conversion of selected factories to firing of natural gas.

Specifically the expert will advise on:

(a) General information about the gaseous fuel burning;

(b) Important parts and functions of gaseous fuel burning installations;

(c) Reduction of gas pressure and working principles setting and failures of reduction equipment;

(d) Safety valves, their working principles, controls, setting and repairments;

(e) Burners with the working instructions, setting, failures and repairments;

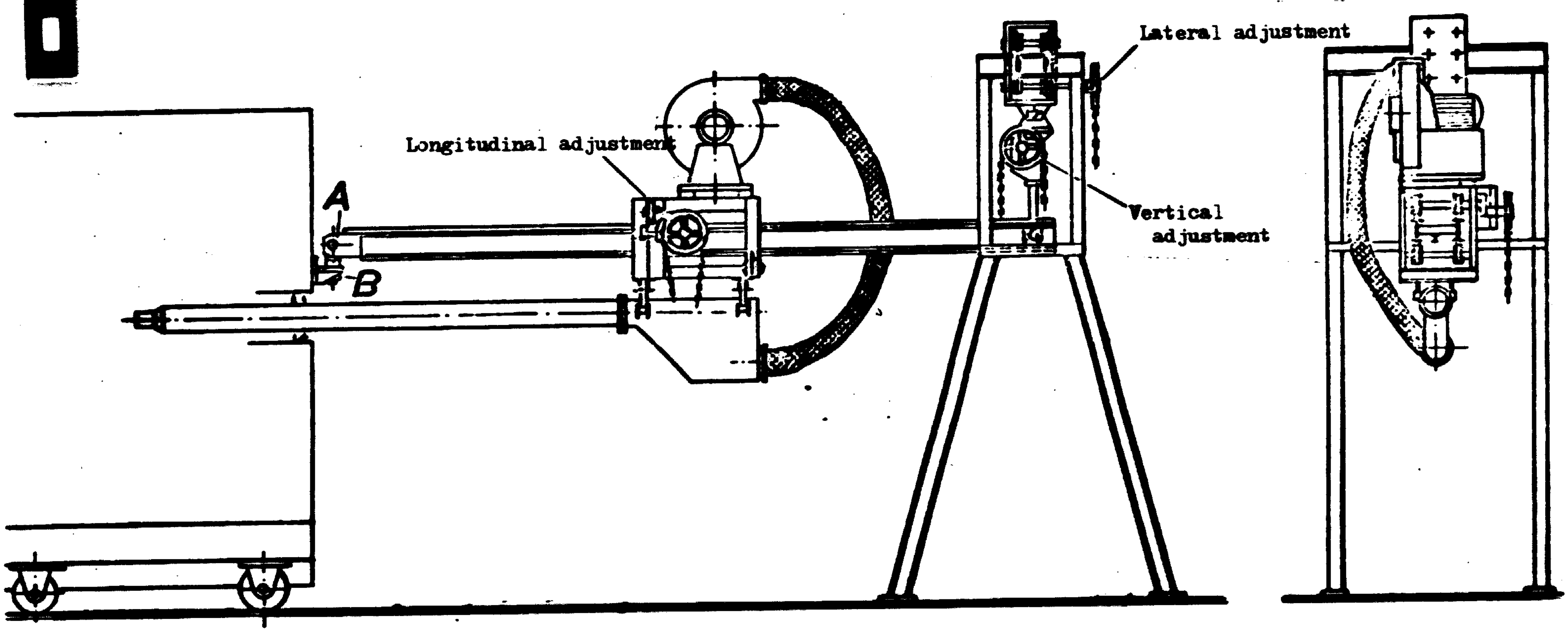
(f) Ground coal burning with natural gas and related principles;

(g) The subject of safety principles so far the gaseous fuel burning.

Language:	English
Qualifioations:	Industrial engineer with relevant experience from the cement field

Annex II

PILLARD OIL-FIRING BURNER
KB 150/3



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