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FUEL RESEARCH INSTITUTE

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TECHNICAL

NO. 47 OF 1968.

A PRELIMINARY STUDY OF HEATING AND COOKING REQUIREMENTS OF URBAN BANTU

OUTEUR:
AUTHOR: H. T. SORGNIT.

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INTRODUCTION

Research conducted at the Fuel Research Institute on the smokeless combustion of bituminous coal in small appliances has been aimed at the development of a cooking stove suitable for Bantu housing. The attention was, so far, focussed on the combustion chamber. Satisfactory, smokeless operation could be obtained with various prototypes provided that certain basic conditions were satisfied. One of these is that sufficient air - primary as well as secondary air - is available to ensure the combustion of solid fuel and of volatile products released from it. In the type of domestic appliance considered, this means that provision must be made for sufficient natural draught. The chimney draught can actually be relatively small. Thus in a well-designed apparatus with all joints properly sealed so that there is no spoil draught, an initial chimney draught of ½ to 1mm has been found to be adequate to ensure practically smoke-free operation even when kindling the fire in a cold appliance. As the fire develops, the gas temperature in the chimney rises to give a higher draught and thus to ensure smokeless combustion at full load.

To achieve this initial draught an effective chimney height of 10 to 12 feet was found to be necessary.

Smokeless combustion may be achieved at somewhat lower chimney heights. However, the dimensions of a combustion chamber in which this can be done at relatively low chimney heights would generally be too small for the coal size gradings available in Bantu townships.

The ..../

The above applies to brickwork or reasonably well-insulated chimneys. If the chimney is merely a mild steel stov pipe, exposed over most of its length to the outer atmosphere whereby stack gases are cooled rapidly an effective height* of some 14 to 16 feet may be necessary.

In order to obtain some idea of the conditions in Bantu townships and also of the heat requirements of Bantu households, the City Council of Pretoria was approached and permission was obtained to visit the Mamelodi township. The assistance rendered by the City Council's officers during this visit is gratefully acknowledged.

HEAT REQUIREMENTS OF BANTU HOUSEHOLDS

The information obtained during this visit from observations and discussions with Municipal officials and members of the Bantu community may be summed up as follows:-

Basically, one can distinguish between two types of Bantu households viz.:

(a) the permanently attended households and

(b) the households left unattended during all working days.

(a) The Permanently Attended Households:

Here some members of the family leave early in the morning, usually before 7 o'clock, for work. These members of

the ..../

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* For the purpose of this report the "effective chimney height" is defined as the height of a straight chimney from the stove top to the top of the chimney. In practice there may be elbows (bends) in a stove pipe. In such an event the resistance to gas flow due to such bends or any other constriction must be compensated for by increasing the height so as to obtain the same draught as with the ideal straight chimney of the stated "effective height".

the family would like to have some warm water available immediately for washing and prefer to have a hot drink and possibly some porridge before leaving.

School going children can leave somewhat later, but it is also desired that they may have hot water, a hot drink and porridge before leaving.

The housewife and infants stay at home. They may have some coffee or tea and cold porridge (left over from the day before or the early morning meal of the workers) at any time between nine and eleven o'clock. In between that time and the late afternoon they may partake from time to time of coffee, tea, porridge or slightly cooked food.

The main meal is served in the late afternoon or early evening. Those who have meat for this meal will start cooking this meat in water from about 2 p.m. The preparation of mealie porridge is started at about 4 p.m.

Such households would, therefore, like to have heat available for the rapid heating of water and cooking early in the morning and then at a lower level for most of the morning while full heating should be available from about 2 p.m.

During the winter months space heating is desirable during the day as well as most of the night. During the summer months space heating should be avoided!

(b) Households Left Unattended During the Day.

In these households all the members of the family leave in the early morning not to return before about 4.30 p.m. In some cases one member of the family may return at about 2 p.m.

These families desire to have a rapid heat source to prepare hot water and a light meal early in the morning. Similarly, a rapid and quite intensive heat source is required in the afternoon so that a meal can still be prepared before it becomes too late.

A fire .../

A fire might be kept going (for space heating) during the day but this would be unattended. Rapid space heating in the late afternoon of winter days would be desirable and some degree of space heating during winter nights is preferred. They also desire a heat source that will not heat the house during the summer months.

The general requirements are therefore:

(1) It should be possible to generate maximum heat for cooking in a stove as soon as possible after kindling the fire.

(2) If possible, the heat release should be adjustable so that full output can be obtained, after banking, in a matter of minutes.

(3) The stove should be adjustable to give heat for cooking only or for cooking and space heating at the same time - possibly at different heat release rates.

(4) It is desirable to be able to bank the fire, so as either to yield some level of space heating, unattended, for periods of up to 8 hours (winter space heating during the night) or merely to avoid rekindling the fire when maximum heat is again required.

(5) It would naturally be to the householders advantage to have an efficient appliance since this will save fuel and will reduce or eliminate the smoke nuisance.

(6) It is desired to have a coal-burning stove as this is presently the cheapest fuel.

EQUIPMENT USED AT PRESENT

All the Bantu houses visited were equipped with some type of cooking stove, ranging from the simplest types to quite sophisticated models. Some of these stoves have large combustion chambers and consequently large heat releasing or radiating surfaces (cooking surface or space heating surface) that may, however, also be detrimental (because of

their ..../

their cooling effect) to efficient combustion. These combustion spaces can easily be overloaded with fuel. For these and other reasons such as air leaks, and poor draught, the fire may smoulder for long periods and even under favourable conditions it may take more than an hour to get a pot of water to boil - much longer under less favourable (e.g., winter) conditions. During all this time the stove may generate smoke, more or less, copiously.

Such stoves are, therefore, of little use for the early morning heat requirements and most Bantu households seem to have a paraffin stove for all emergency cooking. Paraffin is, however, used sparingly because of its relatively high price.

It was also gathered that many stoves have too low a heat release rate to provide the winter space heating requirements and recourse is then had to "Mpaolas" or braziers.

These may also be used for cooking and other heating purposes throughout the year. They have the advantage over the cooking stove in that they can be taken out of the house so as to avoid a heat release inside the house during summer.

Some Bantu appear to have little confidence in modern equipment and prepare their food in the three-legged kaffir pots using coal as fuel.

Examples of these alternatives are shown in the accompanying photographs. Some households employ them all, others have, perforce, to confine themselves to one or two - and then frequently the more primitive types.

These observations and discussions served to underline the facts that:

(1) The Bantu community must necessarily concentrate on the use of bituminous coal to satisfy energy needs because this is by far the cheapest fuel.

(2) The appliances presently used are operating inefficiently so that the Bantu cannot hope to satisfy his essential energy needs in a satisfactory manner.

Some .../

Some of the reasons for this inefficiency can now be considered.

SOME REASONS FOR POOR STOVE PERFORMANCE

The low efficiency of these cooking stoves may be ascribed in part to the fact that many of the stoves used were not designed originally to burn bituminous coal at all.

The cheaper stoves have practically no insulation and it may, therefore, be difficult, if not impossible, to establish an intense fire zone.

Joints in such stoves are not, or only poorly, sealed.

A further reason may be that the stoves are not operated properly. There is, for example, a tendency to overload the combustion chamber with fuel, leaving no free space above the coal for the secondary combustion of volatile products that may be evolved. Even when this is allowed for, the temperature in this region may be too low to ensure ignition of the combustible gases and vapours. Proper mixing of combustible gas and secondary air (if available) is hardly achieved.

However, even the best stove can only be run properly if sufficient air can be drawn through the combustion chamber. Special attention was, therefore, given during this visit to the chimneys provided in various houses.

The standard Bantu house in Mamelodi is about 20 feet wide on the gable front. The height from the floor to gable top is about 10ft 3ins and the roof drops to a height of about 8ft at the side walls, giving a roof pitch of about $12\frac{1}{2}^{o}$. The kitchen is usually situated at the gable side of the house.

The stoves inspected have a height of about 2' 3" to 2' 8" from kitchen floor to the hot-plate top when mounted on legs. This height never exceeded 3 feet even when the stoves were mounted on bricks.

Some .../

Some houses have an asbestos-cement pipe chimney having a double elbow or bend to take the pipe through the wall and lead it up outside the house along the wall to the ridge top. Others have brick built chimneys, built along the outer wall and requiring one elbow in the stove pipe to take it into the chimney. Both types of chimney are not carried further than about a half to one foot above ridge height.

The height from the top of the stove to the top of the chimney is, therefore, about 8 feet. Due to the resistance effect of bends the "effective chimney height" would, therefore, be only 4 to 6 feet depending on the number of elbows used.

In a few isolated cases it was found that another length of asbestos-cement pipe had been added to such chimneys giving an effective chimney height of about 10 feet.

Some house occupants have carried a mild-steel stove pipe chimney vertically up from the stove through the roof. These chimneys also end at, or just above roof height and thus have an effective height of about 8 feet.

Stove pipe chimneys may also be carried through the wall, using a double elbow. These also end, at best, at about ridge height. Since a cowling or chimney top is usually not provided, such mild steel chimneys exposed to the atmosphere corrode rapidly due to the effect of rain and condensate from the smoke effluent, so that their effective height is soon reduced to a very low dimension. The chimney may actually have no better effect than a pipe merely carried through the wall - and many such chimneys were actually seen.

Very obviously the chimneys are generally too short to ensure an effective draught.

House owners have made some effort to improve conditions by, for example, inclining chimney pipes away from the prevailing wind direction or fitting any existing chimney top to serve as a wind shield. In some cases an additional chimney is provided. Its object is,apparently to draw smoke from under the roof out of the house.

The generally .../

The generally inadequacy of the chimney draught (too low chimneys and appreciable spoil draught) not only causes poor performance and pollution of the outer atmosphere (see photos) but, coupled with the poor condition of many stoves, is also responsible for quite severe contamination of the atmosphere in the house, as proved by the blackening of the walls and the roof.

CONCLUSION:

While many of the heating appliances presently used by the Bantu have intrinsic defects and the appliances are frequently, badly operated, the major cause of poor performance is the inadequate draught created by the existing chimneys.

Most of these chimneys are provided by the Bantu themselves. Their aim is merely to remove smoke from the house and there appears to be very little appreciation of the basic function of a chimney viz. to create the draught required to ensure proper combustion.

Research such as that being done at the Institute on the development of efficient combustion chambers to burn bituminous coal efficiently and smokelessly, has already yielded sufficiently promising results to be confident that quite small, efficient appliances can be developed to generate heat for food preparation or space heating.

It is very desirable that such appliances should be available and to convince the Bantu and others that it is in their interest to acquire such equipment as soon as it is available.

It must, however, be realised that the performance of the best appliances will be poor unless the basic requirement of adequate draught, which depends so much on proper chimney height and design is not met.

Attention must, therefore, again be drawn to the recommendation on chimney height for Bantu housing prepared

by the ..../

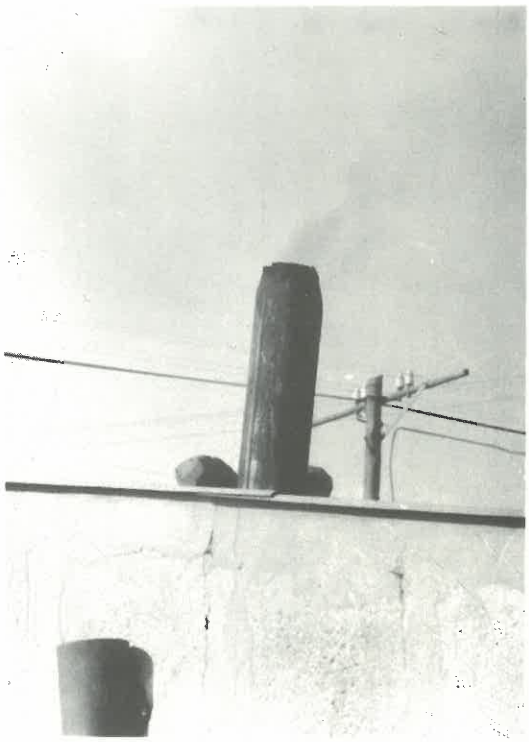
by the National Building Research Institute. Every effort should be made to convince local authorities and the Bantu that the acceptance of such recommendations is not only a pre-requisite for the more efficient and, therefore, economical use of fuel but also for improving the atmospheric conditions in Bantu townships and the surrounding countryside.

Even at the present time, with only less efficient appliances available, an appreciable improvement in atmospheric conditions could be obtained by adopting these recommendations on chimney design.

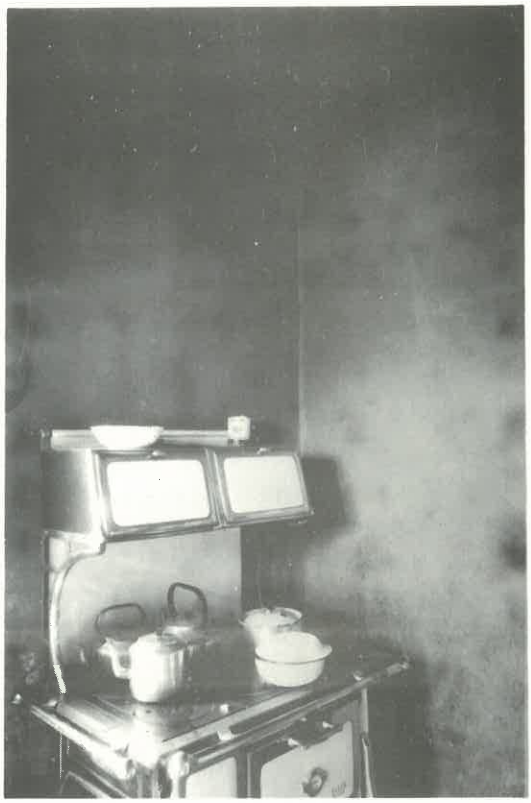
(SIGNED) H. T. SORGNIT
SENIOR RESEARCH OFFICER.

PRETORIA.
11th November, 1968.

Some full-size chimneys

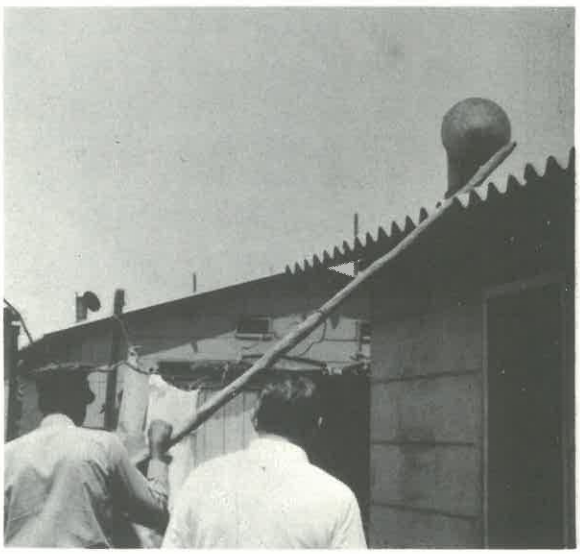


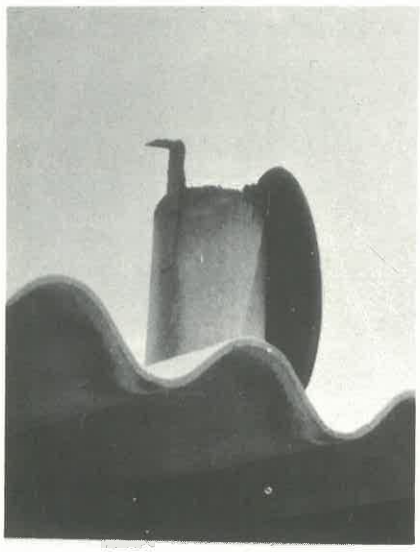
Two chimneys for one stove ?



Type of stoves and stove pipes in Bantu kitchens and the smoky conditions of the walls

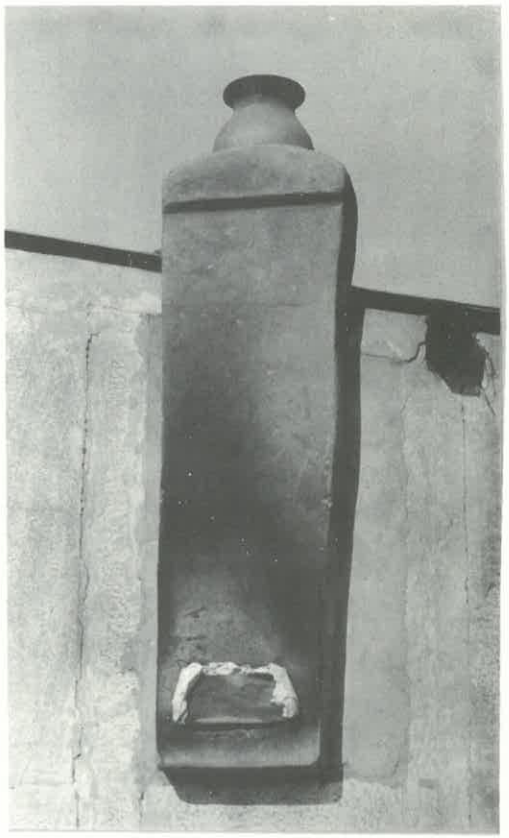
Thi s family had the stove, the Mpaola and a paraffin stove simultaneously in operat ion

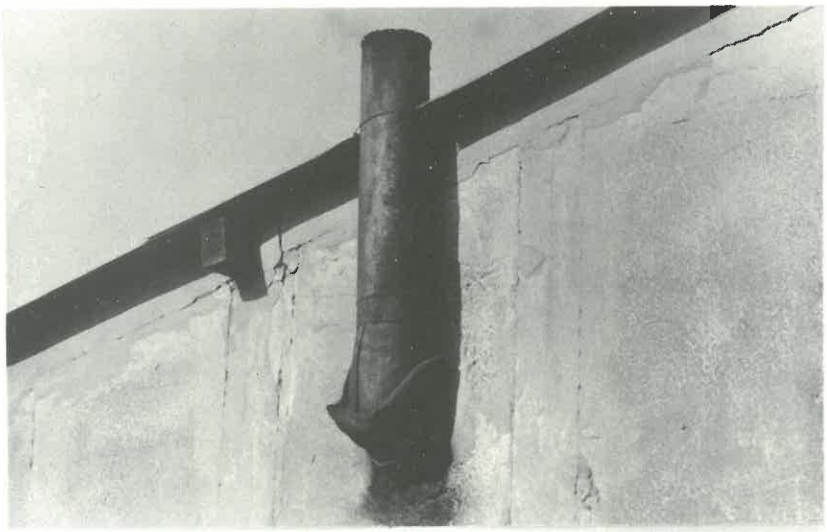




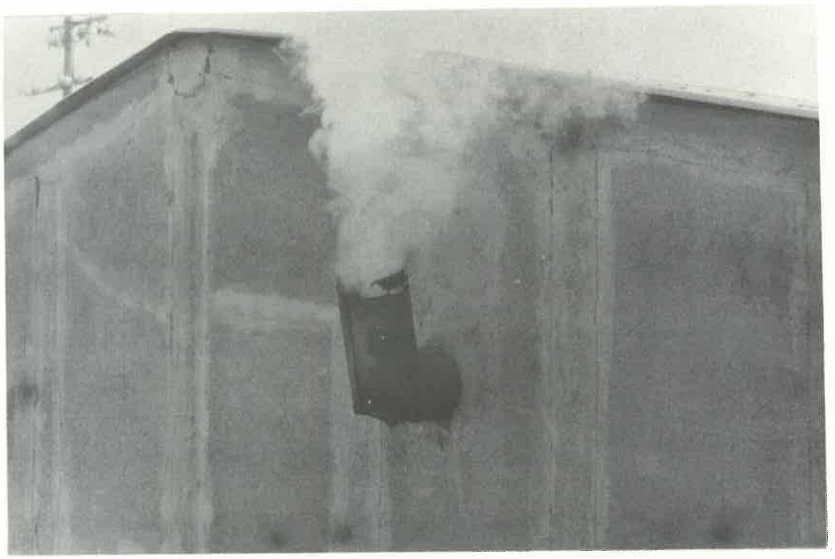
Attempts to improve the draught —

and the results.

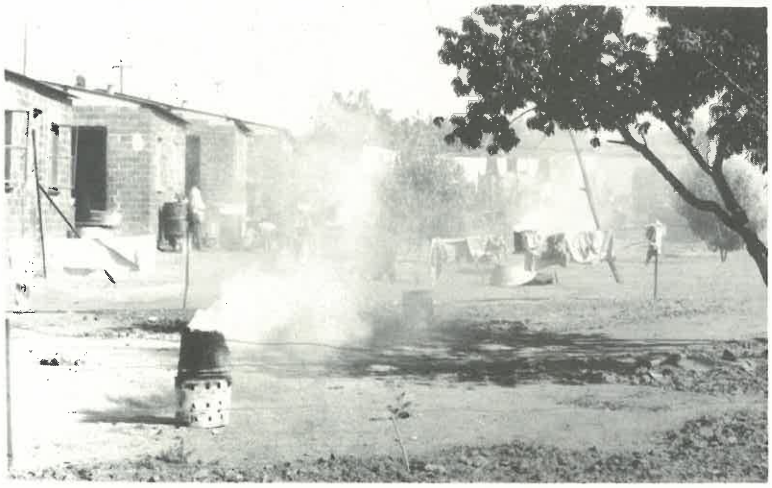


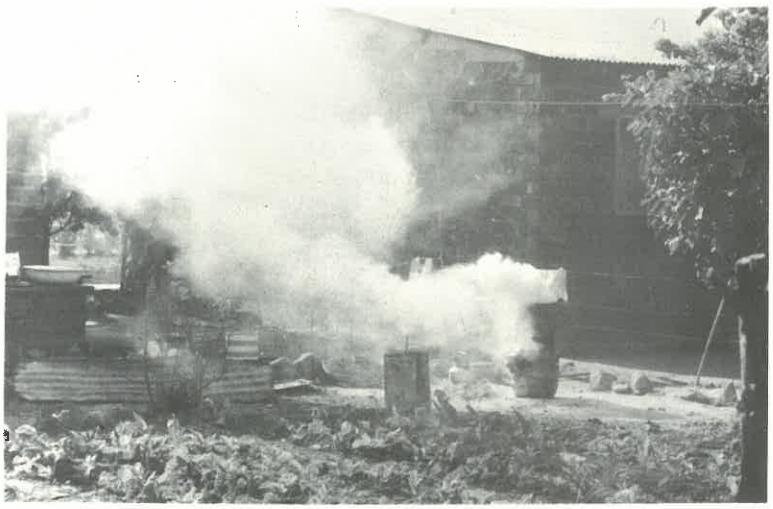


Some intermediate results of the battle against the soot



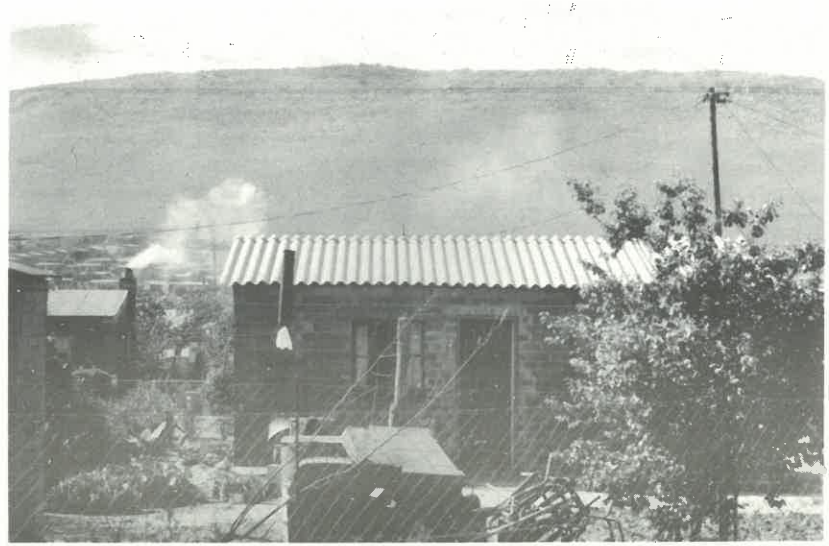
The final stage of the lost battle against soot and smoke





Mpaolas during ignition

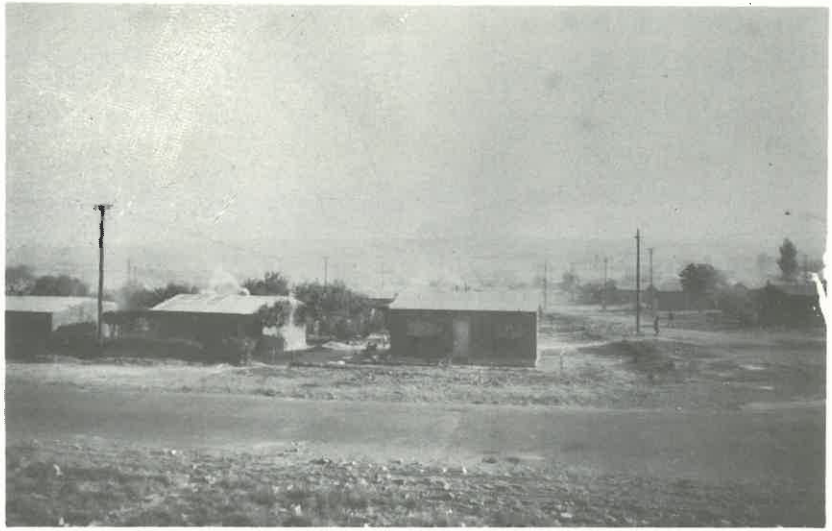
Kaffir pot with coal fire



Scenes at commencement of fire making

Before

and



during

fire making

Noon

5.15
p.m.

Panoramic views of Mamelodi Township at noon and at 5.15 p.m. on 9th October, 1968