IN CONFIDENCE

F.R. Note No. 212/1955
Research Programme
Objective B5/2 (C)

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

FIRE IN WOOD CHIP INSULATION

by

P. C. Bowes

SUMMARY

This note describes an investigation into the cause of a fire that is believed to have started in wood chip insulation surrounding a warm air duct above a veneer drying kiln.

The cause of the fire could not be determined but, of the possible causes considered, ignition by an external source is regarded as the most probable.

F.1015/10/60

October, 1955.

Fire Research Station,
Station Road,
Boreham Wood,
Herts.

FIRE IN WOOD CHIP INSULATION

by

P. C. Bowes

INTRODUCTION

A fire occurred in the roof space of a veneer drying kiln at the furniture factory of Messrs. Harris Lebus Limited, Finsbury Works, Tottenham, N.17, on 6th May, 1955. The fire was believed to have started in wood-chip insulation that partially surrounded a metal duct carrying steam-heated air to the kiln.

The Joint Fire Research Organization was consulted by Mr. G. T. Deeming, Fire Surveyor to the Phoenix Assurance Company, on the possibility of spontaneous ignition having occurred in the wood chips. The scene of the fire was visited by the author with Mr. M. D. Perry of the Joint Fire Research Organization together with Mr. Deeming, on 16th June for the purpose of reviewing the evidence for spontaneous ignition. We were met by Mr. H. Wilds, Chief Officer of the factory fire brigade, who gave us a first-hand account of the fire.

LOCATION AND DESCRIPTION OF KILN

Site

The kiln is the east-west leg of the L-shaped building No. 7 shown in Fig. 1 and is situated in the south west corner of the factory site, which is bounded on the west side by the main line through Tottenham and, on the south-east side, by a line to Barking. The main line is level and at factory ground-level, but the Barking line is a gradient and about 15 ft. above the factory ground-level.

Kiln

The kiln was constructed by conversion of an older building, probably a stable, in about the year 1935. Outline drawings of the kiln are shown in Figs. 2 and 3. The following description of the kiln is confined to features relevant to the account of the fire.

The roof of the building was boarded and slated and had a louvred ventilator along the whole length. The roof space, in which the fire occurred, was floored with one inch boarding on 9 in. x 3 in. joists, to the underside of which the ceiling of the kiln was attached. The east gable end abutted on a brick wall, and the west end, over the entrance to the kiln, was boarded in and fitted with a door.

Air was circulated in a closed path through the kiln by a fan driven by an external electric motor. On leaving the fan the air passed over a series of five, independently controlled, steam-heated radiators into a header in the roof space over the kiln. Short pipes, at intervals of 6 ft. along the header, conducted the heated air into the kiln. Return air to the fan left the kiln via a concrete channel that skirted the south wall of the kiln and which communicated at the centre with a duct passing under the floor of the kiln. The exit channel was covered with a grating.

The header (above) was close against the north wall and occupied the whole length of the roof space. It consisted of rectangular sections, 3 ft. by 2 ft. 6 in. by 6 ft. long, of 20 gauge steel with flanged joints and was supported on T-section steel brackets at 6 ft. centres. The down pipes leading into the kiln were 10 in. in diameter, flanged, and riveted to the header. Collars of thin plywood were fitted round the down pipes where they passed through the floor of the roof space and where they emerged through the ceiling of the kiln.

The header and down pipes were cased in from the floor to the top of the header by a light wooden casing that extended the whole length of the roof space. The space enclosed by the header, floor, and casing was filled with wood chips. This wood-chip insulation was 20 in. deep between the header and the floor and was about 6 in. thick between the header and the casing. From marks on the side of the header it appeared that the wood chips had extended about half way up. This probably represented the level to which the chips had finally settled some time after being put in. It was learnt that the chips had been in place since well before the war, and it seems probable that they were put in either when the kiln was constructed or shortly afterwards.

The roof space was fitted with sprinklers, but there was none above the header. The nearest sprinklers to the header were on a line parallel with it, but about 2 ft. away and slightly below the level of the top of the casing.

The kiln had not been used for veneer drying for a long time. But it had been in continuous use for three months before the fire for the purpose of drying some corrugated cardboard. During this period the kiln was maintained at a temperature of 75°F; for which purpose one only of the steam radiators in the heater chamber was turned on.

THE FIRE

The following account of the course of the fire is based mainly on information supplied by Mr. Wilds.

The kiln was last entered at about 5 p.m. on the day of the fire, when a load of corrugated cardboard was put in to it. At 5.58 p.m. the sprinkler alarm sounded. When Mr. Wilds arrived on the scene of the fire the matchboarding in the west end of the gable had been burnt through above the end of the header, and the roof space above the header was involved for about one third of its length from the west end. It was clear that the fire had reached an advanced stage before the sprinklers were actuated; in view of the position of the sprinklers (Fig. 2) this is understandable.

The fire was attacked by the factory fire brigade with two hose reel jets, from each end of the roof, until a larger hose and jet was brought into play. The public fire brigade was not called. Six sprinklers at the western end operated.

Due to the strong west wind prevailing at the time, and to the difficulty of approaching the roof space, the fire spread rapidly towards the east end and became intense at the centre. The stop message was sent to Control at 6.14 p.m. but the fire was not extinguished until about 7 p.m. Turning over continued until about 10 p.m.

As a result of the fire the roof ventilator above the header was destroyed for the whole length. In the centre, where the fire had been most intense and lasted longest, the floor immediately under the header was burnt through and the joists underneath were heavily charred. The header was slightly distorted and some of its joints had opened slightly. The roof space south of the line of the ventilator was undamaged.

Where the wooden casing had not been destroyed by fire it was pulled away in order to attack fire in the wood-chip insulation. Pockets of fire were found in the wood chips along the whole length. The largest pocket of fire was round the first down pipe at the west end of the header (Fig. 4). At this point the wood chips were heavily charred and were glowing on the surface where they had shrunk away from the underside of the header. The upper side of the plywood collar surrounding the down

pipe was charred and the inside of the casing was more heavily charred than the outside. A hole had been burnt, at the point indicated in Fig. 4, through the matchboarding that filled the gable end. The matchboarding was heavily charred round this hole on the inside. Above a height of about 3 ft. the matchboarding had been destroyed.

From the above observations Mr. Wilds concluded that the fire originated in the wood-chip insulation at the west end, and that it had been in progress for some time before the main outbreak that actuated the sprinklers. He suggested that the break out had occurred first through the hole burnt in the matchboarding (Fig. 4); the fire had then spread up the outside of the boarding and, aided by the strong west wind, had burnt through the boarding into the roof space above the header.

The cause of the fire was not discovered, but it was tentatively suggested that the cause might have been spontaneous ignition in the wood chips. It was considered that the wood chips might have been damp since the roof was known to leak.

AUTHORS OBSERVATIONS

Examination of wood chips

When seen by the author most of the wood-chip insulation that had not been destroyed in the fire had been cleared from under the header and deposited in heaps inside the kiln. However, some of the insulation remained between the first and second down pipes at the west end and appeared not to have been disturbed. The chips here were compacted and damp but did not appear to have rotted appreciably; it appeared probable that they had been wetted by water used to extinguish the fire.

The chips were charred in places near the second down pipe and, on digging them out, it was found that, in one place, the chips were charred along a narrow irregular path for a distance of about 18 inches. There was a fairly sharp boundary between the completely charred chips and the undamaged chips along this path, and it was considered to have been the path of smouldering. There was no extensive region, surrounding the carbonised chips, showing intermediate degrees of heat damage as might have been expected if spontaneous heating had occurred.

A sample of wood chips from the position described above was examined in the laboratory and had an ignition temperature of 240°C., as determined by the rising temperature method. This value was similar to that obtained for a number of different woods by the same method. There was no indication that the wood chips would ignite at a lower temperature than normal wood.

Extent of fire in wood chips

All the down pipes from the header, with the exception of one at the centre, had tarry deposits on them that indicated that they had had smouldering chips in contact with them or near to them.

The hole in the matchboarding (Fig. 4), mentioned above, was examined. The heavy charring round the hole extended for 2-3 inches on the inside of the matchboarding. Immediately above this charred area there was about 6 in. of undamaged wood and then more charring. It was quite clear that there had been an intense and localised fire in the chips near this hole. This fire is likely to have been little more than slow smouldering until the hole was burnt through and an air draught was admitted. On the other hand, there was a crack between the boards (due to a broken tongue) approximately in the position indicated in Fig. 4 and there may have been a similar crack where the hole developed.

Course of the fire

The outside of the matchboarding in the west gable end (Fig. 4) appeared to be undamaged for at least a foot in between the hole and the upper part that was destroyed. For the fire to spread from the hole to the upper part it would have been necessary for a jet of flame to have issued from the hole and to have been blown back by the west wind to ignite the boarding at a higher point. It is not easy to understand how the required jet of flame could have occurred.

It is probable that the wood chips, being consolidated and partly enclosed, would smoulder almost as slowly as sawdust. The fact that the hole had been burnt through within an hour of when the kiln was last visited, and at a point that was evidently submerged in undamaged wood chips, could indicate that the fire originated in the wood chips fairly near the hole. On the other hand, a smouldering fire could have been in progress in the wood chips at a fair distance from the end, and for a long time before the main outbreak and the burning through of the hole. Even in the latter case, however, the fire could not have originated very far from the west end; otherwise the smouldering would have been unlikely to have reached, and to have burnt through, the west end matchboarding at about the same time as the main outbreak. In this latter case, smouldering could have been in progress for several days, or perhaps even a week or so, before the outbreak.

It is suggested that the main outbreak, following a smouldering fire in the wood chips, occurred inside the roof space near the west end, and the upper part of the matchboarding in the gable was burnt through from the inside before the sprinklers were operated.

Possible causes of fire

Careless smoking. The roof space could not be reached without a ladder. It was probably too inaccessible to have been used as a place for surreptitious smoking. The fire is correspondingly unlikely to have been caused by a cigarette end or a discarded match.

Electrical fault. A lead carrying sockets for light bulbs was strung along the roof space near the header. A wooden bayonet plug was fitted at the east end of the lead and it was noticed that the wires were exposed where the lead entered the cap of the plug. The socket into which the plug was intended to fit could not be found. It was learnt that the circuit had been dead for some time and could not have been responsible for ignition.

Sparks. The factory chimney is 140 ft. in height, roughly north of the drying kiln, and about 450 ft. away. It seems impossible that a spark from the factory chimney could have reached the roof of the kiln.

The railway line nearest to the west end of the kiln is the Tottenham line which passes within about 45 ft.; the Barking line passes within about 85 ft. of the west end of the kiln. It is conceivable that a spark may have reached the roof from a locomotive on the Tottenham line, perhaps with the aid of a strong west wind, but, in order to reach and ignite the wood-chip insulation, the spark would have had to pass through the louvred ventilator or through a hole in the roof of the ventilator.

It is not known whether there were holes in the roof of the ventilator; none was seen in the roof that remained over the kiln that was likely to have been there before the fire, and it was noticed that the roof of the north-south limb of the building had its slates intact. However, it was clear that the roof had leaked, since the roof boarding was rotten in places over the kiln.

In the troughs of the corrugated roof of the building 7A (Fig. 1) surrounding the kiln, and in corners elsewhere, there were deposits of fine wood dust of up to about an inch in thickness. It was learnt that these deposits were known to smoulder. It is, perhaps, possible that a similar deposit leading into the ventilator above the header had been ignited by a spark from the railway, and that some of the smouldering dust had fallen into the wood chips and so set up smouldering that eventually developed into the fire.

It must be admitted that ignition by a spark or ember is only a remote possibility but, at the same time, the fire in the wood chips was the first in twenty years.

Fire in air circulation system. The possibility of a fire having occurred first in the air circulation system was considered. The exit channel under the grating along the south wall of the kiln and the inside of the header were both inspected; the latter through the inspection port shown in Fig. 3. Apart from a thin coating of dust, probably wood dust, the channel and header were free from combustible material.

However, the inside of the header was coated with a tar deposit, on the top and the side nearest the wall, in the central sections where the fire had been most intense. The steam radiator nearest the exit from the air heating chamber was just visible from the inspection port and did not appear to have any deposit on it.

The tar deposit could have been due to the thermal decomposition of wood dust inside the header and to the entry of smoke and, perhaps, flame through the opened joints in the header and through a gap, evidently the result of distortion, that was seen at the junction of the header and the heater chamber. Thus, the tar deposit did not necessarily indicate that there had been a fire in the header. The absence of a deposit on the bottom and far side (from the inspection port) of the header implied that these faces had been too hot for condensation of the tar.

Spontaneous ignition. There is a widely held belief that timber beams, wood shavings and sawdust can ignite spontaneously after prolonged exposure to temperatures of the order of 100-200°C. Such temperatures are well below the values of about 250°C or more obtained for the ignition temperature of wood in tests employing short term heating. Some examples of fires in wood shavings and corrugated cardboard, in contact with steam and hot water pipes, which appeared to have been due to spontaneous ignition have been published by Virtala et al. (1) (2). In one of these examples wood shavings are believed to have ignited spontaneously after prolonged exposure to a temperature of not more than 65°C (149°F).

The mechanism of the spontaneous ignition of wood from such low temperatures is not at present understood, and the process has not been reproduced under experimental conditions. However, Mitchell (3) has shown that a block of wood fibreboard, 22 inches between faces, can heat to ignition in 150 hours with an ambient temperature as low as 109°C.

Although, in the light of the above, no definite conclusion is possible, it is considered very unlikely that the wood chips, in a dry condition, could have heated to ignition in contact with the header at a temperature as low as 24°C (75°F).

There was evidence that the wood chips could have been damp in parts. Thus, the roof leaked and, further, a three-inch sprinkler supply pipe that ran along the junction of the wall and the floor under the east half of the header, and which would have been buried in the wood chips, was heavily rusted; also, the floor boards appeared to be somewhat rotted at the eastern end.

Sawdust and wood waste from green wood, and from seasoned wood if damp, is able to heat spontaneously from ordinary atmospheric temperatures. But heating to ignition is known with reasonable certainty to occur only in large heaps of green sawdust and wood waste (4-6) containing many thousands of cubic feet.

It is considered that spontaneous heating to ignition, following the ingress of water, is unlikely to have occurred in the wood chips.

CONCLUSIONS

1. The fire in the roof space probably started as a smouldering fire in the wood-chip insulation near the west end of the header.

2. The cause of the fire could not be determined.

3. Of the possible causes considered, the most probable is thought to be a spark from outside - probably from the railway at the west end - which either entered and ignited the wood chips directly or ignited a dust deposit outside, which then fell into the wood chips and ignited them in turn.

4. In the light of what is known of spontaneous ignition in wood, spontaneous ignition is regarded as unlikely to have been the cause. Further, the possibility that the fire was due to an external cause prevents the incident from being regarded as an example of spontaneous ignition in wood under conditions hitherto unrecorded.

ACKNOWLEDGMENTS

Figs. 1, 2 and 3 have been prepared from plans kindly obtained for us by Mr. G. T. Deeming. The author is indebted to Mr. Deeming for his kind cooperation and to Messrs. Harris Lebus Ltd., for the facilities for studying this incident.

REFERENCES

1. Virtala V., Oksanen S., and Frilund, F., "On spontaneous ignition, Methods for determination of tendency to spontaneous ignition". State Institute for Technical Research Helsingfors, 1949, (English Summary.

2. Virtala V., "Ignition (of timber and shavings) through radiation and by prolonged heating at low temperatures". V.F.D.B. Zeit., 1953, 2, 1.

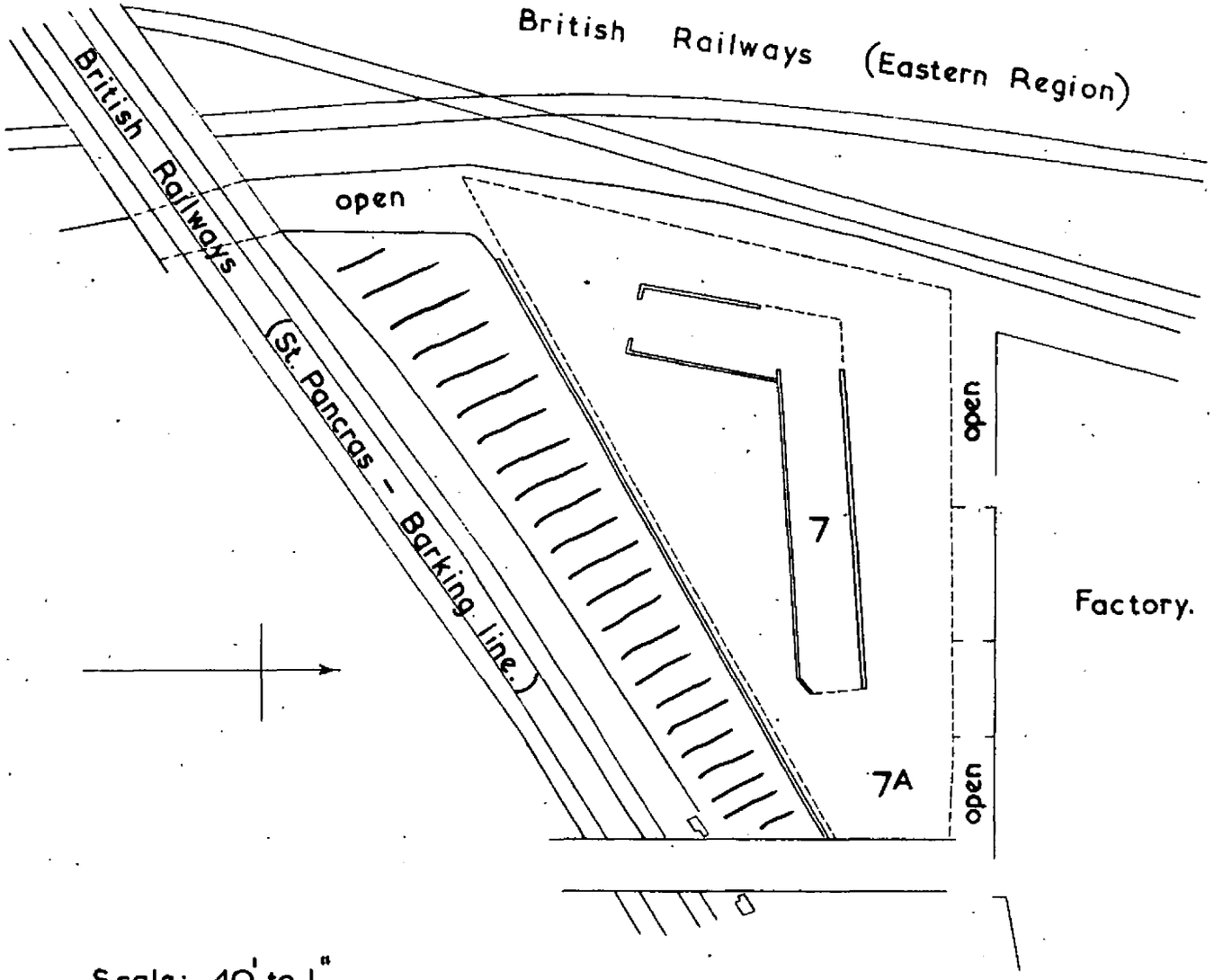
3. Mitchell, N. D., "New light on self ignition". National Fire Protection Association (U.S.A.), Quarterly, 1951, 45, 165.

4. Boals, R. B., "Experience with large woodwaste piles". Power, 1945, 89.

5. Bergstrom, H., "The spontaneous heating of wood and the origin of fusain". Proc. 3rd Int. Conf. Bitum. Coal, 1931, 2, 787-96.

6. Bowes, P. C., "Spontaneous heating and ignition in heaps of Sawdust" Department of Scientific and Industrial Research and Fire Offices' Committee and Joint Fire Research Organization. F.R. Note No. 187. A review.

ERH



Scale: 40' to 1"

FIG.I. PLAN OF SITE.

FR. 212.

11/9/58

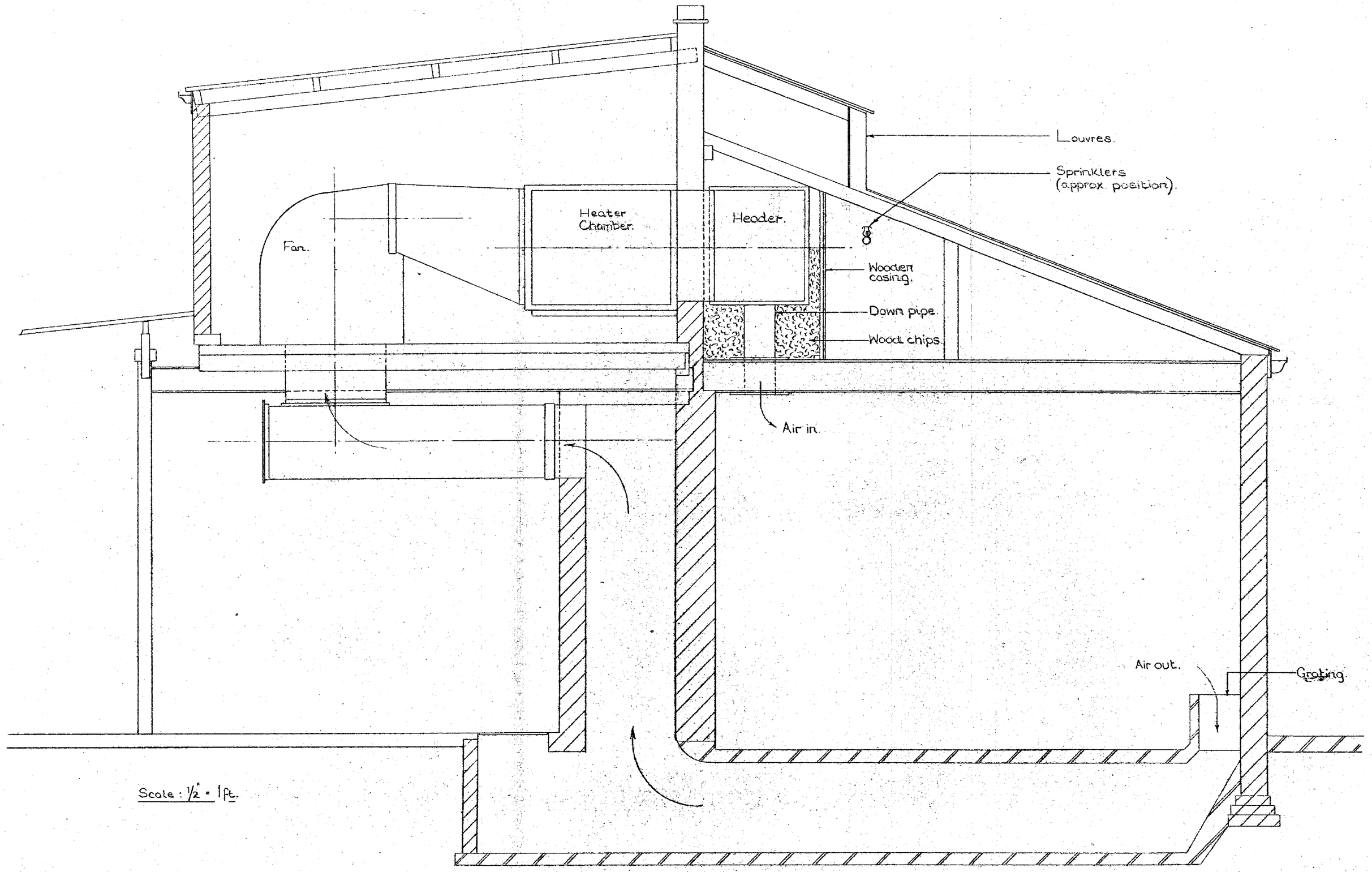


FIG. 2. VENEER DRYING KILN - SECTIONAL ELEVATION.

2/182 FR 212

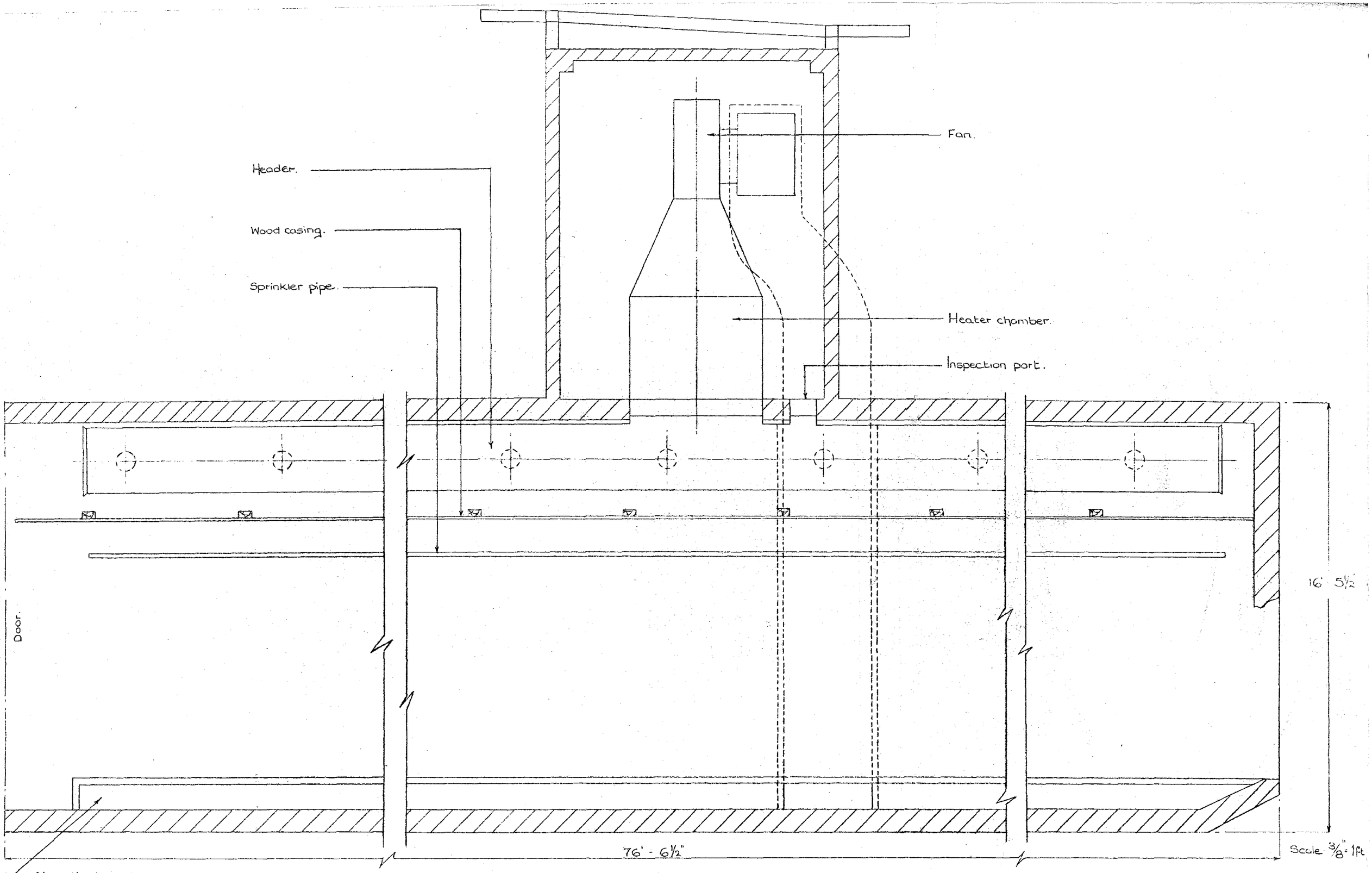


FIG. 3. VENEER DRYING KILN - PLAN.

FR 212 . 4/53

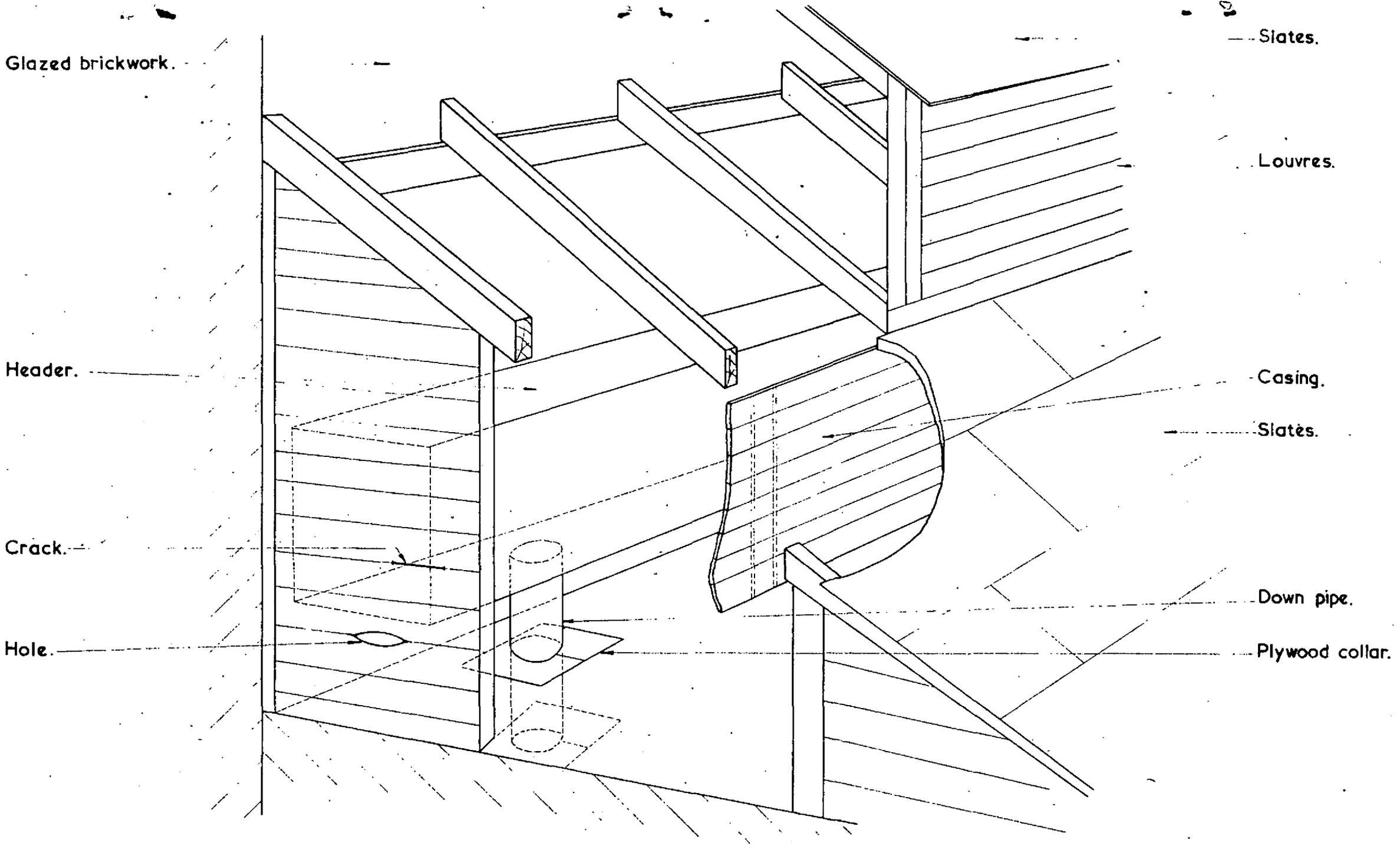


FIG. 4. CUT AWAY SKETCH OF WEST END OF ROOF SPACE.

FR. 212.

6761/1