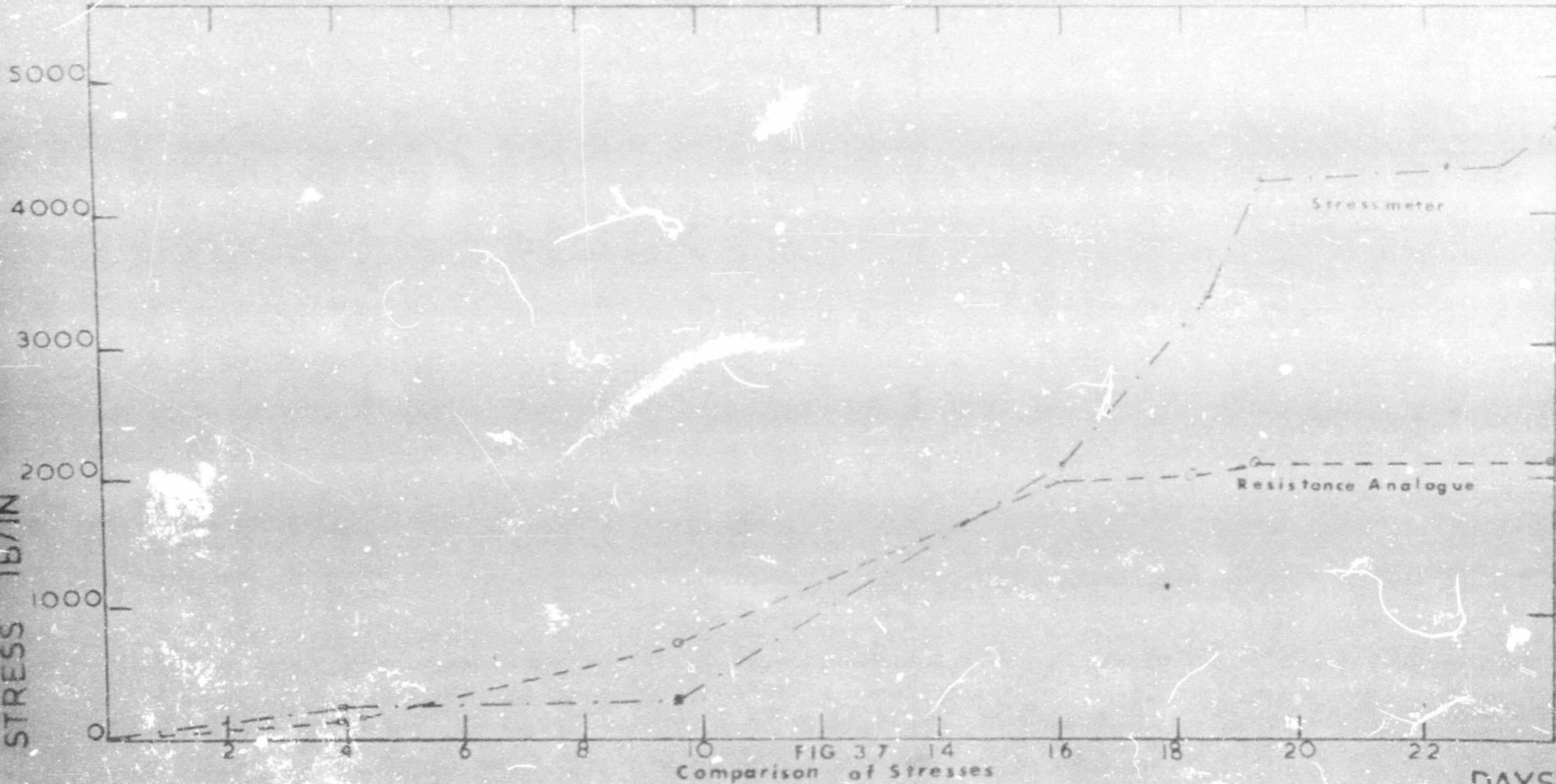

FIG 3.7
Comparison of Stresses
Resistance Analogue and Stressmeter
2436 Top North Pillar

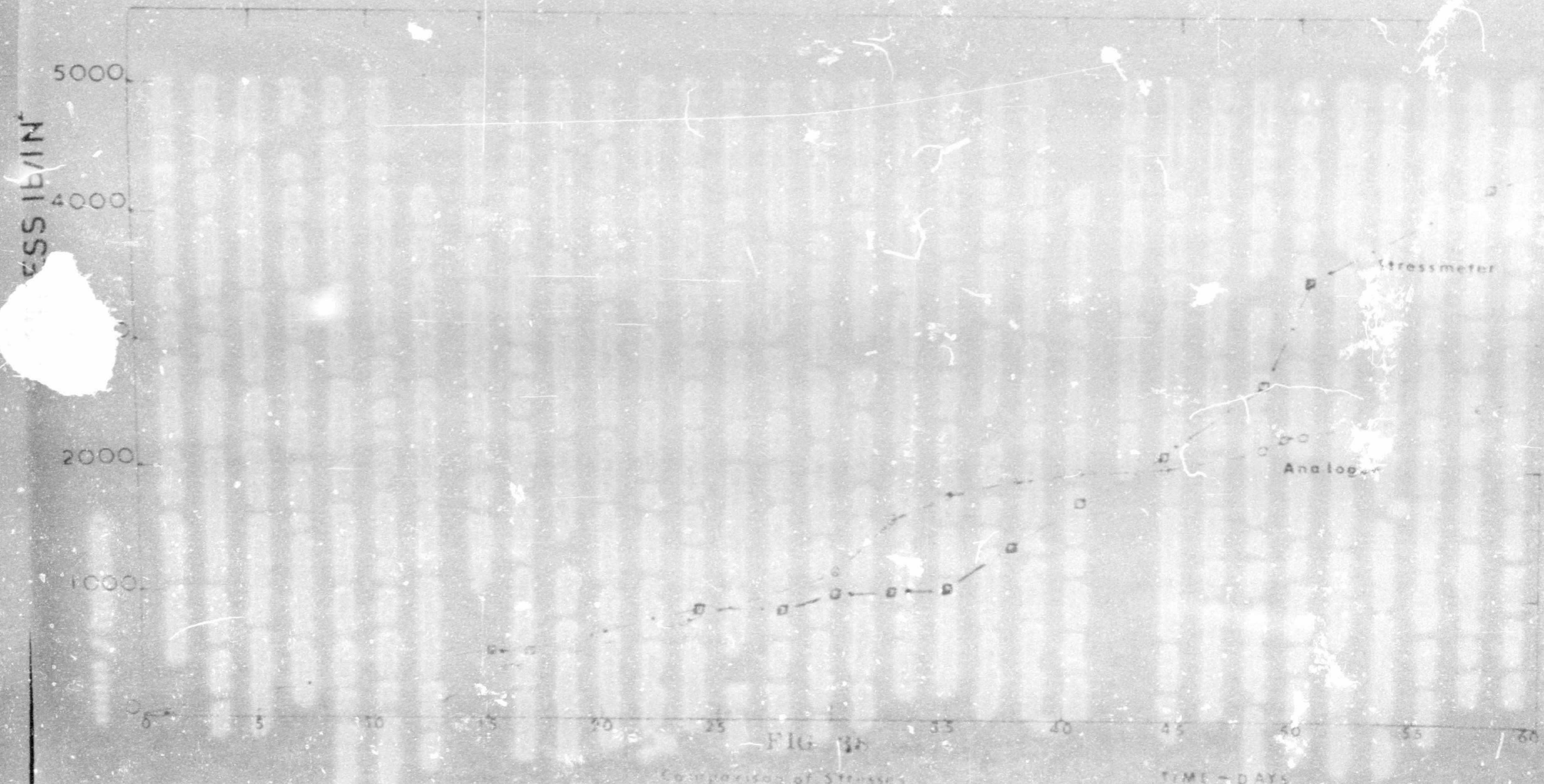

FIG. 38

Comparison of Stresses
Resistance Analogue - Stressmeter

2426 Top North Pillar

and thereafter fell to a lower stress magnitude, (Table III). The magnitudes of the stresses measured were less than the overburden stress and less than the stress computed on the Analogue, except for one value in 2436 Bottom South face where the measured stress of 7,9000 lbs./ins.^{2} compares favourably with 8,700 lbs./ins.^{2} obtained on the Resistance Analogue. The ratio of the minor to the major principal stress was found to fall between 0.1 and 0.3. Since the magnitudes of the "in-situ" stresses as measured on St. Helena were all less than the theoretical stresses, it must be concluded that the measurements were probably made within the fractured zone.

The results of stress meter tests in 2436 and 2426 Stopes show that stress changes in excess of 4,000 lbs./ins.^{2} occurred at the pillar centres. This is a minimum reading, since fringes in excess of five cannot be read accurately. In order to measure higher stress changes a meter of lower sensitivity is required. The change in stress readings made at the centre of the stope pillar compared with the results on the Resistance Analogue, prove that the behaviour of the pillar is elastic at the centre during the development stage. It can be seen from FIGS. 36 to 38 that actual and Analogue stresses are about the same for stress changes of about 2,000 lbs./ins.^{2}. Above this point the underground stress exceeds the theoretical stress measured on the Resistance Analogue. This is considered to be due to the failure of the pillar sides, causing the stress to increase in the remaining part of the pillar.

The low magnitude of measured stress indicates that the rock at a distance from 4 ft. to 8 ft. ahead of the face is fractured, and therefore the rock forming the pillars must also be fractured. As the stope face moves away from a developed pillar visual observations indicate that pillar fracturing continues. Further, the results of the stress measurements prove that the rock at the centre of the internal stope pillar behaves

elastically / ......

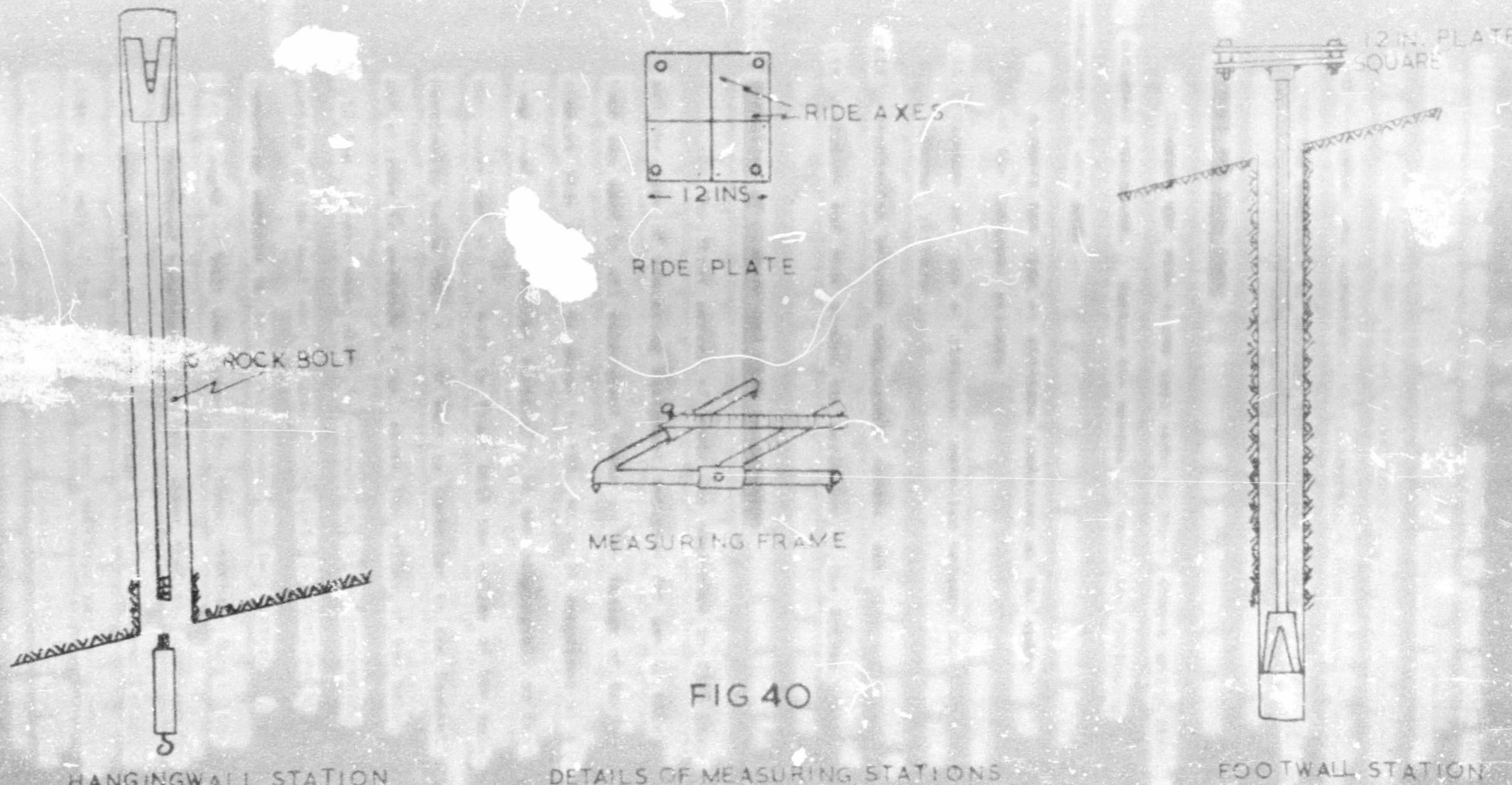

FIG 40

DETAILS OF MEASURING STATIONS

elastically in the early stages. Therefore it seems likely that pillars may crack into large blocks as the excavation increases, but that each block may behave elastically. As the stress measuring equipment was unsuitable for measuring a wide range of stresses, it was not possible to measure the ultimate strength of the pillar.

6.2 Closure and Ride Tests:

Closure and ride tests were made in three stopes using specially designed equipment. During the series of tests the following measurements were made :-

(i) closure and ride at stations installed at the sides of the internal pillars;

(ii) closure and ride at stations installed between the internal pillars;

(iii) separation between hangingwall strata, and;

(iv) closure and ride around the perimeter of the drives.

6.2.1 Technique of Closure and Ride Measurement:

The first series of tests was conducted in 2323 Stope and the type of measuring equipment designed for use in this test was used in all subsequent tests. The design of the closure ride station is shown in FIG. 40. It comprises a 5 ft. long roof bolt installed vertically in the hangingwall so that the lower end of the bolt is flush with the collar of the hole. Vertically below this a roof bolt is installed in the footwall and allowed to protrude 6 ins. above the collar of the hole. A 12 ins. square base plate is screwed on to the protruding portion of the bolt and an upper ride plate is levelled by inserting washers on the bolts between the two plates. A 5 ft. length of bolt was chosen for these stations due to the badly fractured hangingwall. This meant that the stations had to be installed in the track cuttings, since the normal stoping width was only 42 ins. As the track cuttings may have resulted in increased ride movement, a simple design of station was used

to / ......

to measure ride between the tracks for comparison purposes.

It was observed that bed separation had taken place in 2324 Centre Gully between a 2 ft. thick shale band 10 ft. up in the hangingwall, and the middling quartzite above. The bed separation meter shown in FIG. 42 was therefore designed to measure movement over a distance of 15 ft. between the Basal reef quartzite and the middling quartzite. This type of meter was used in 2323 Stope only and not in the other stopes.

Measurement of closure was by graduated steel tape, combined with a steel rule and cursor to give an accuracy of one sixty-fourth of an inch. Ride was determined by measuring the point of a plumb-bob from the two axes machined on the ride plate as shown in FIG. 40. This measurement was made normal to the machined axes by a steel rule graduated in sixty-fourths of an inch. The axes of the ride plate were placed on line of dip and strike at installation. Several ideas were tried to combine the ride and closure instruments by using an extension piece in the tip of the plumb-bob to measure closure variation. However, neither a mild steel tubular plumb-bob with a 2 ft. long solid extension piece, nor a large plumb-bob head with a 9 ins. of extension and hung from twine and chandelier chain proved suitable. The reasons being that stretch occurred in the flexible suspension, making it unsuitable for closure measurements, and small movements of the tubular plumb-bob caused variation in the ride reading.

6.2.2 Description of Tests:

The first series of tests was conducted out in 2323 Stope during the removal of the internal pillars. This stope was chosen since the internal pillars were close to the standard pattern and the stope was on the deepest level in the mine. The layout of stations for measuring pillar behaviour, strata movement between pillars, bed separation, and movement around

22 and / ......

· Closure-Ride Stations

⊙ Bed Separation Meters

× Ride Meters

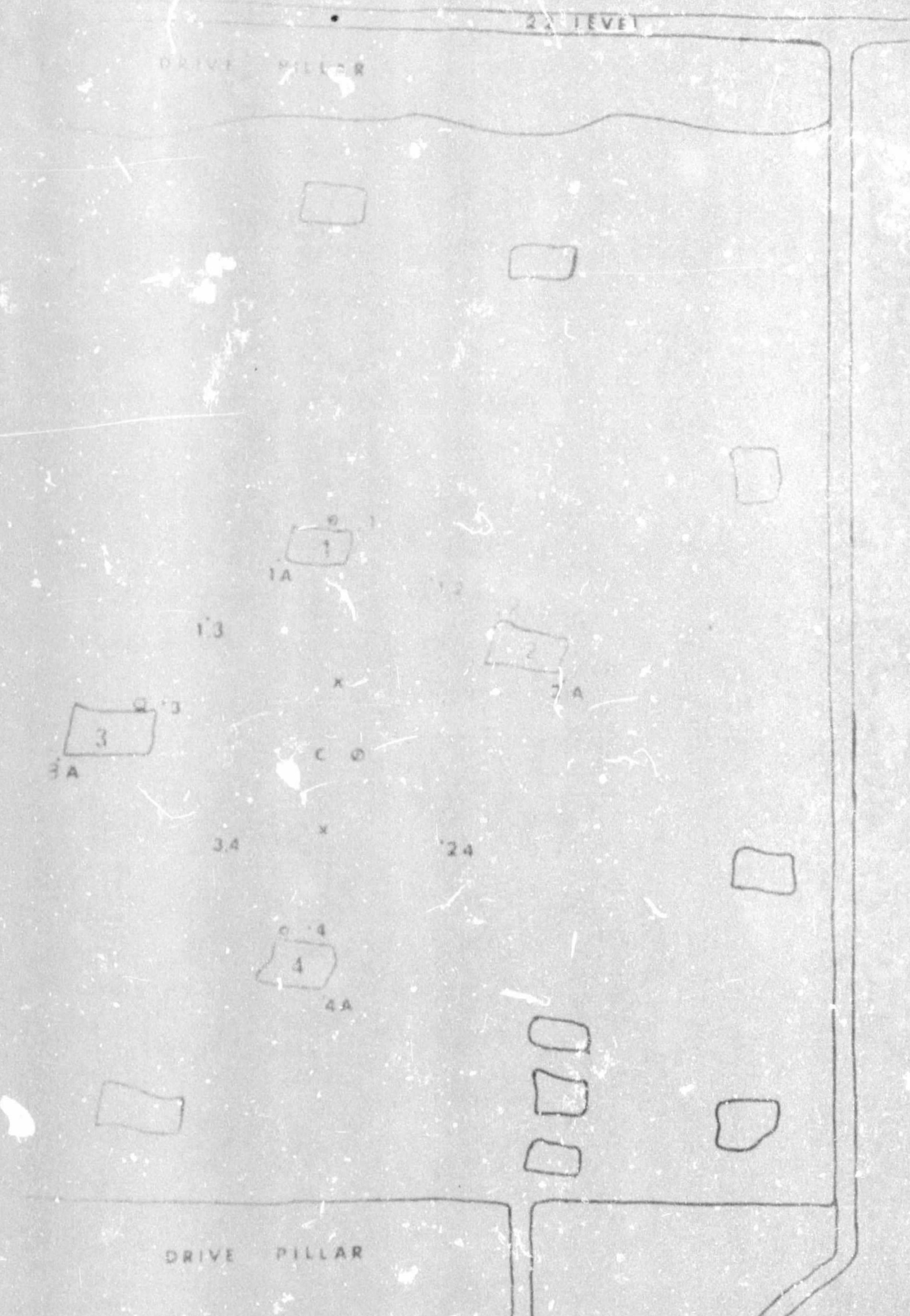

FIG 39

Sketch Showing Positions of Stations

2323 Stope

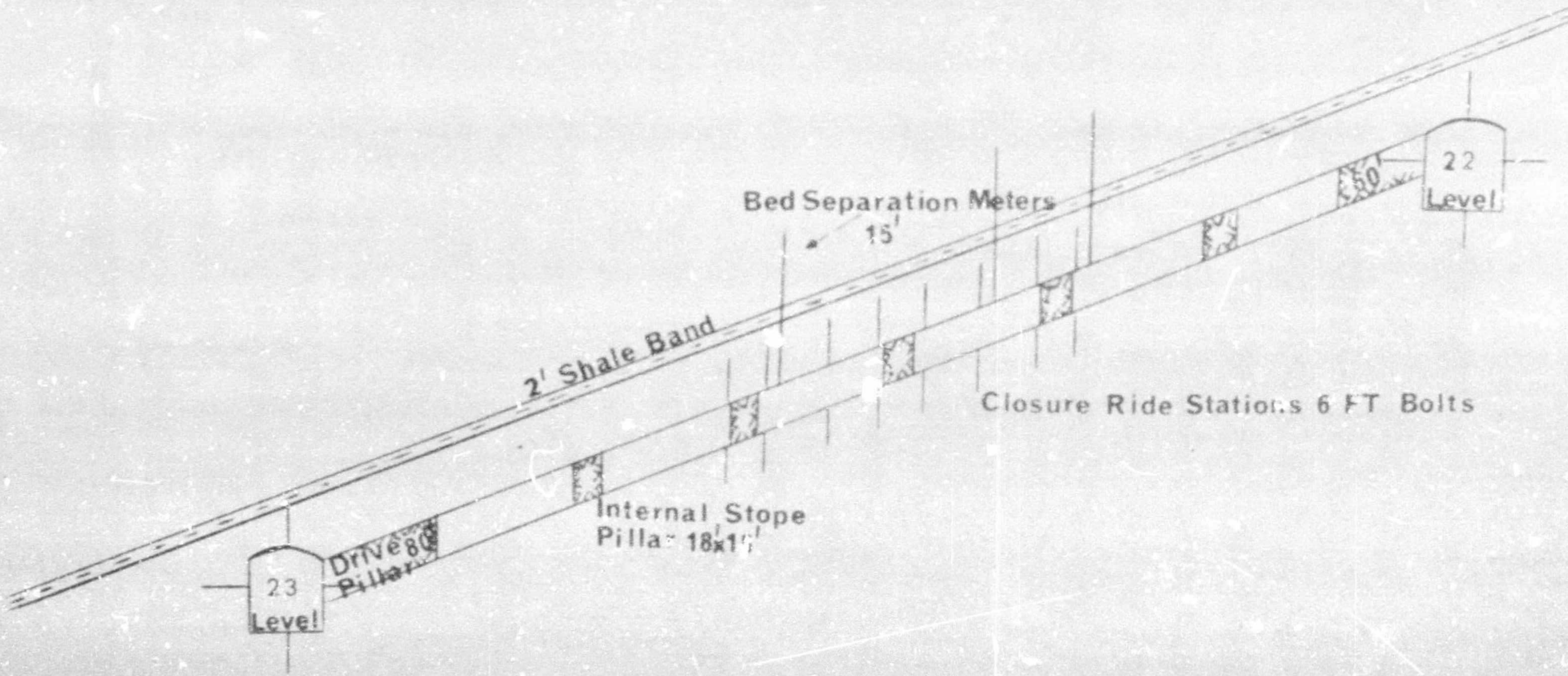

FIG 41

Section Through 2323 Stope Showing Closure Ride and Bed Separation Meters

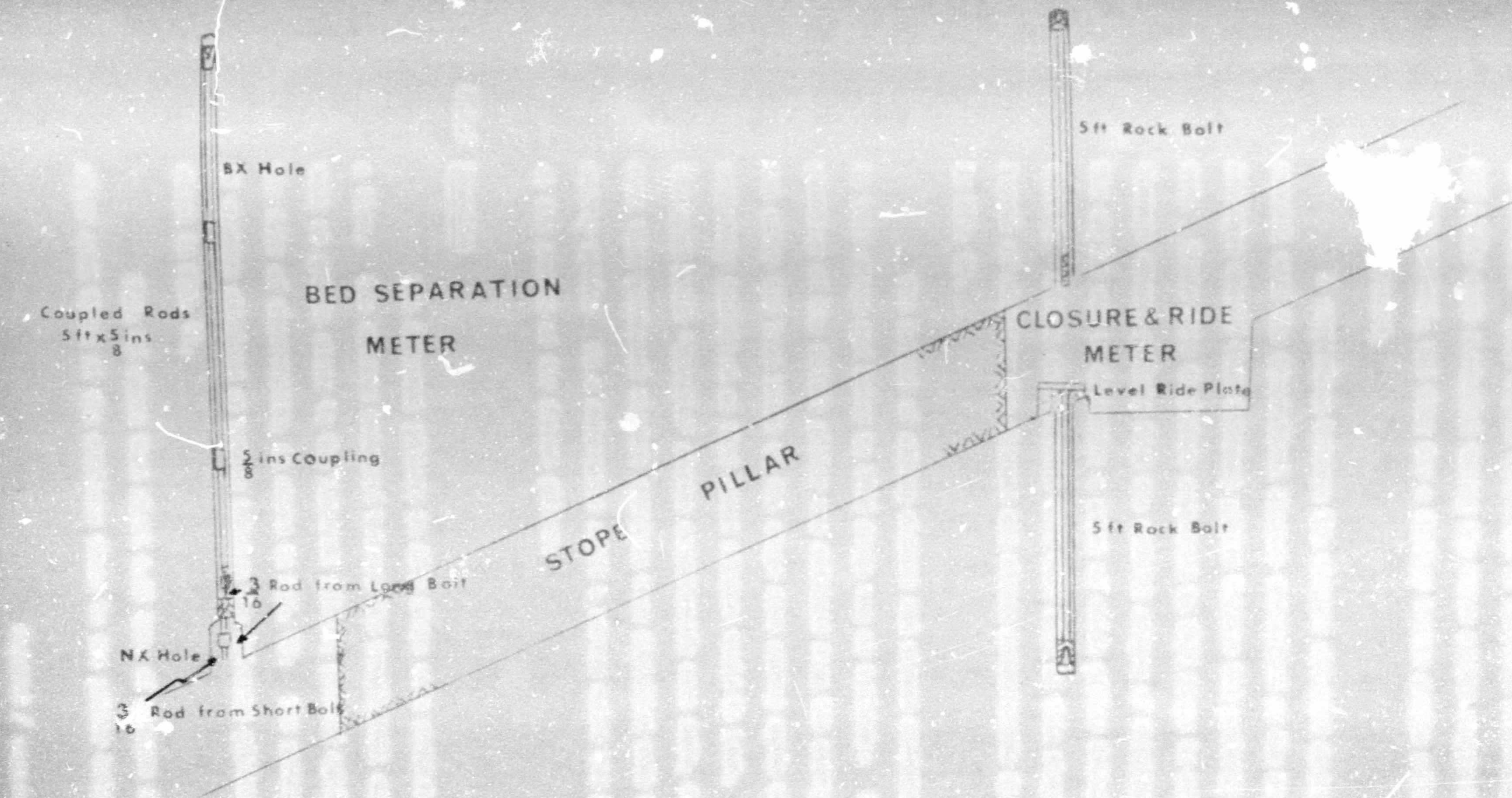

FIG 42

Diagrams of Closure Ride and Bed Separation Meters

22 and 23 Level drives is show... ..G. 39 in plan, and FIG. 41 in section. This layout consisted of nineteen measuring stations, and tests were conducted during the three months required for pillar removal, and then for a further twelve months after all work had ceased.

A comparison between the closure obtained during pillar removal with the the...tical closure determined on the Resistance Analogue showed that internal pillar failure had probably occurred. Tests were therefo.e commenced in 2436 Stope to measure closure around pillars from the initial stages of development. The object was to determine a point at which pillar failure occurred. Stress measurements were also made in this stope. The layout of stations for closure and stress measurements is shown in FIG. 45.

The method of making closure and stress measurements in this stope and later in 2426 Stope was as follows:- The position of the future pillar was obtained from the survey office, and after the last blast on the stope face survey spads were immediately installed so that least closure would be lost. During the next shift "in-situ" stress measurements were made, and at the same time permanent closure stations were installed next to the survey spads. On a subsequent ... ...tress meter was installed at the centre of the future pill...

6.2.3 Results:

The internal pillars in 2323 Stope were removed one at a time. The closure measured between the hangingwall and footwall at points close to the internal pillar, plotted against the date of observation, is shown in FIG. 43. The measurements of closure obtained at points between the internal pillars is shown in FIG. 44.

FIG. 43 shows that about 0.25 ins. of closure occurred after each blast at the stations close to the pillar being

removed / ......

FIG. 43

RELATIONSHIP BETWEEN CLOSURE AND DATE

RELATIONSHIP BETWEEN [illegible]

removed. Steady closure occurred at the other pillars not being mined. The closure occurring at the pillar stations was between [illegible] ins. and 1.25 ins. by the time all pillars had been removed. FIG. 44 shows that steady closure occurred at stations between the pillars and no rapid closure resulted from the blasting of the pillars. A total closure of 0.75 ins. was measured at these stations during the pillar removal stage.

The total time taken to extract the pillars was about three months. Steady closure occurred at all the stations during the twelve months following pillar extraction, and no mining took place during this time. The final closure measured at the end of this period was approximately 1.7 ins. at those stations originally at the pillars, and 1.25 ins. at the stations originally between pillars.

Ride movement in 2323 Stope was very small and, except for one station, was less than 0.5 ins. and was generally in an up-dip direction. The effect of shallow track cuttings on ride was negligible. A maximum of 0.156 ins. occurred in six months at one of the ride stations placed between the tracks. The nearest station in the track cutting showed 0.172 ins. during the same period.

Whilst drilling holes in the hangingwall for bed separation meters, no loss of drilling water occurred, and it was assumed that there was no separation between the beds. This applied to holes drilled at the pillars as well as to those drilled between the pillars. During pillar removal only .047 ins. of bed separation occurred, proving that the Basal reef quartzite, the shale, and the middling quartzite moved almost "en masse".

During the year in which tests were conducted in 2323 Stope, the hangingwall and sidewall movement in 22 and 23 Level drives was very small. The maximum closure measured was 0.25 ins. and the maximum ride movement was 0.125 ins.

There / ......

SKETCH SHOWING

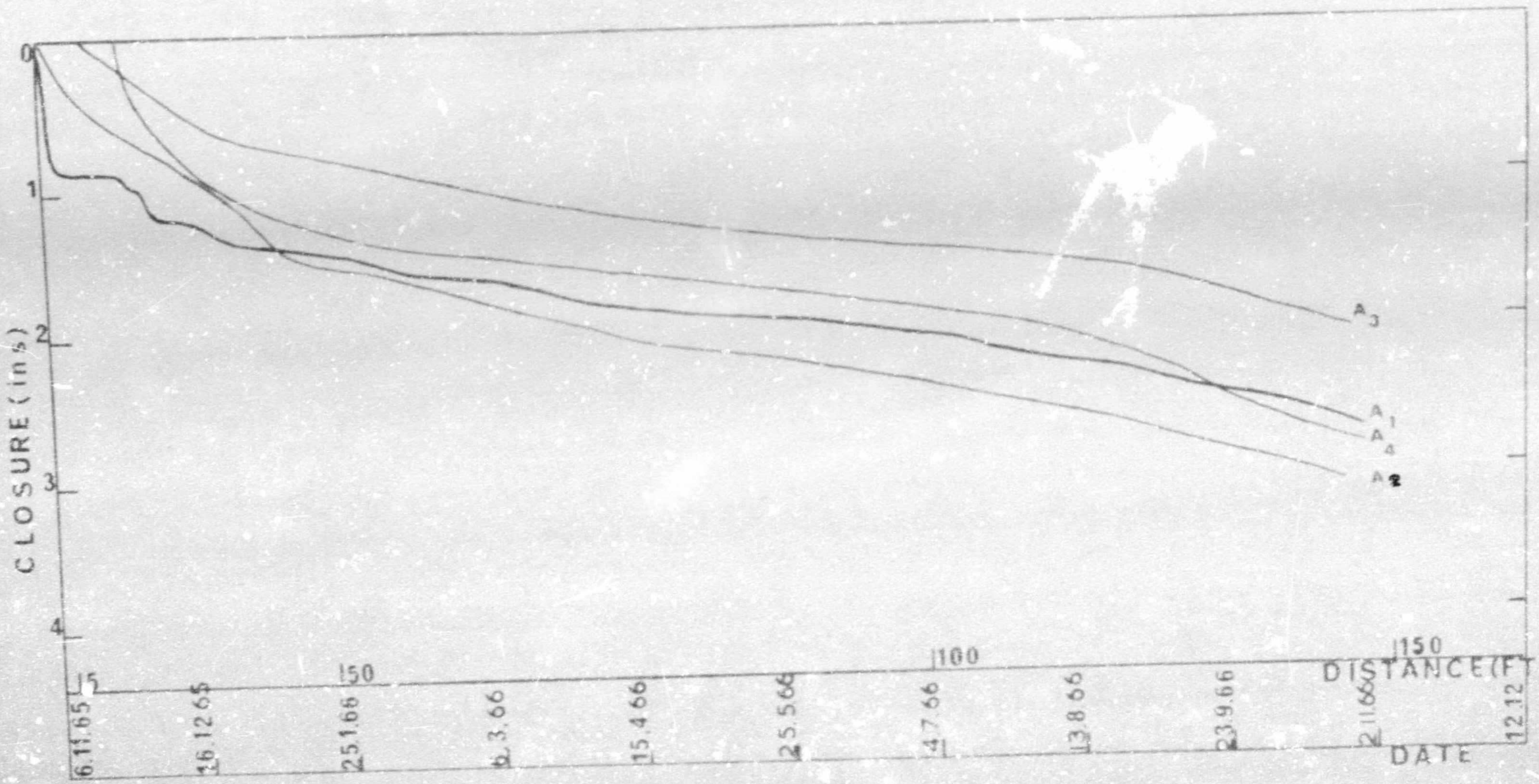

FIG 4b

Relationship Between Closure, Date and Distance of Pillar from Stope Face

2436 Stope

FIG.17

Relationship Between [illegible] Date and Distance [illegible] Pillar from Stope Face

[illegible] Stope

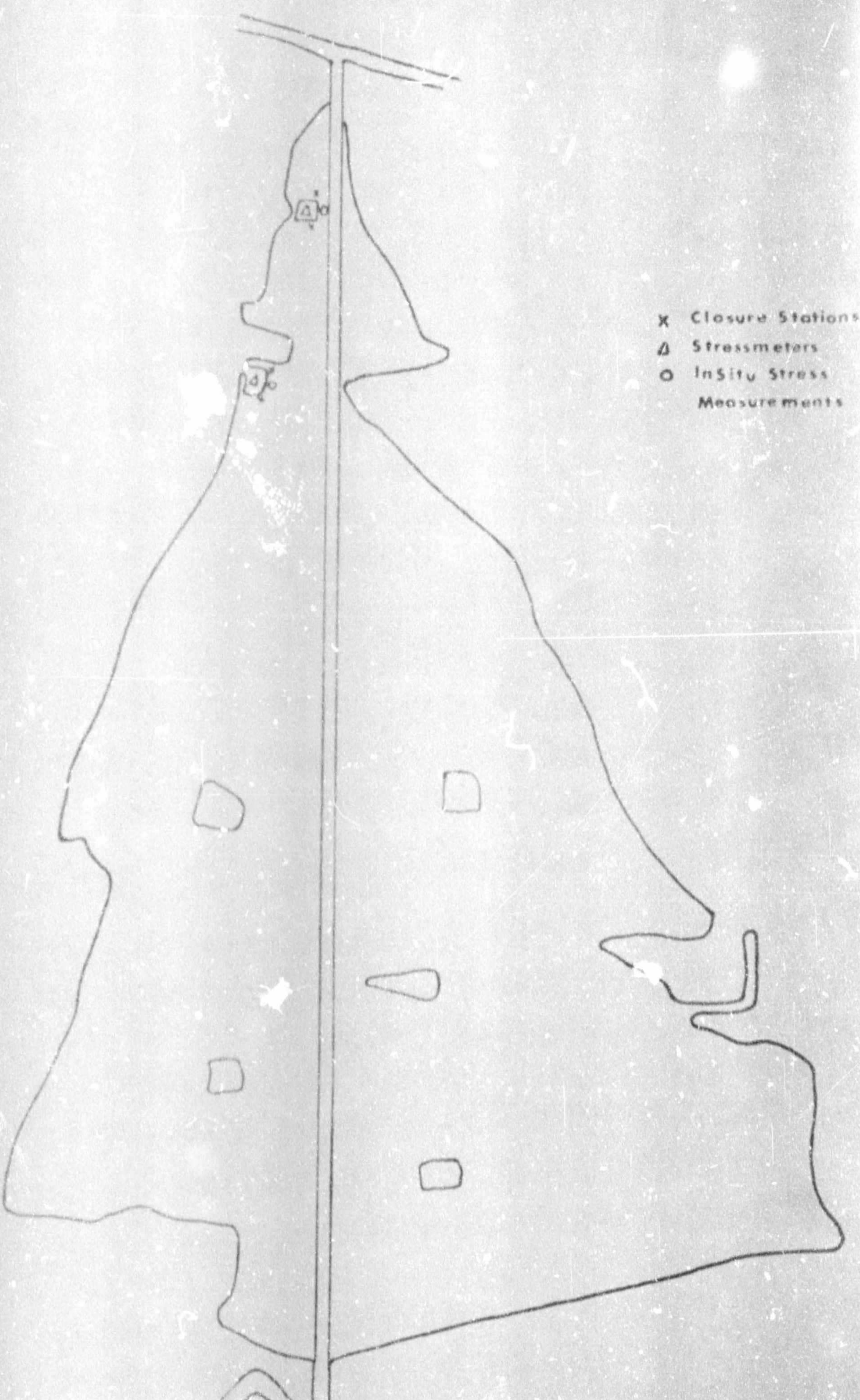

FIG 43

Position of Closure and Stress Measuring Stations
2426 Stope