AN ENQUIRY

IN REGARD TO THE CAUSE OF

SPINNERS' SCROTAL CANCER.

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INTRODUCTION.

SPINNERS' SCROTAL CANCER.

SINCE 1920 the attention of those engaged in cotton spinning has been directed towards the disease known as Scrotal Cancer because of its increased incidence amongst mule spinners.

Anxiety amongst employers has also arisen since the judgment given in 1922 in a Lancashire County Court in favour of a workman suffering from this disease. The judgment of the Court was that upon the evidence laid before it, the disease arose out of and in course of the employment. The evidence was to the effect that the mineral oil used to lubricate the mule, is thrown off by the rotating spindles on to the Faller Shaft and the spinners' overalls. The friction of the shaft on the scrotum as the man leans over it, together with the irritation of the oil, were stated to be the causes of the disease[1].

This judgment was in full accord with what was then, and still is, the general opinion. It would appear to be founded on the fact that some cases of cancer have been reported amongst workmen employed in the processes of refining mineral oils, and amongst shale workers[2].

This question of Spinners' Scrotal Cancer first arrested my attention in 1923 in the course of official visits to cotton mills. Observation caused me to doubt the prevailing opinion as to the cause of the disease. I commenced investigations which led me to express these doubts in my Annual Report for 1923, and to advance a counter opinion. As a result of this Report I was asked to give evidence in June, 1925, before a Special Commission appointed by the Government, which I did accordingly.

At the commencement of my investigations I was met by two difficulties. (1) There would appear to be nothing written or published on this disease in reference to spinners (in any medical journal) except one article by A. H. Southam and S. R. Wilson, of Manchester[3]. (2) No definite information can be had from the local hospitals. Their records are very incomplete or not kept, and the death registers do not help much.

Starting with the definite statements made in Messrs. Southam and Wilson's article[3], I divide my Thesis into three main parts and a conclusion.

I. The Faller Shaft and the process of oiling.

II. The oil as found upon the overalls.

III. A suggested and more evident line of thought as to the cause of this disease.

IV. Conclusion.

THE SPINNING MULE.

Before proceeding to detail the experiments which I have carried out, it would be useful at this stage to give a brief description of the spinning mule and its working.

The spinning mule consists of two main parts, the Creel—which is fixed—and a moving part,—the Carriage. The latter is all that we need consider. It is composed of the Faller Shaft, and the Bolster, both extending the whole length of the mule, anything from 30 to 40 yards. The Faller Shaft, a circular steel rod, stands 33 inches above the floor and carries the wire controlling the tension and direction of the threads during twisting and winding. The Bolster is $6\frac{1}{2}$ inches to the inside of the Faller Shaft, and $4\frac{1}{2}$ inches below, and carries the spindles with the cops. Refer Diagram 1A.

DIAGRAM I.

TRANSVERSE VERTICAL SECTION.

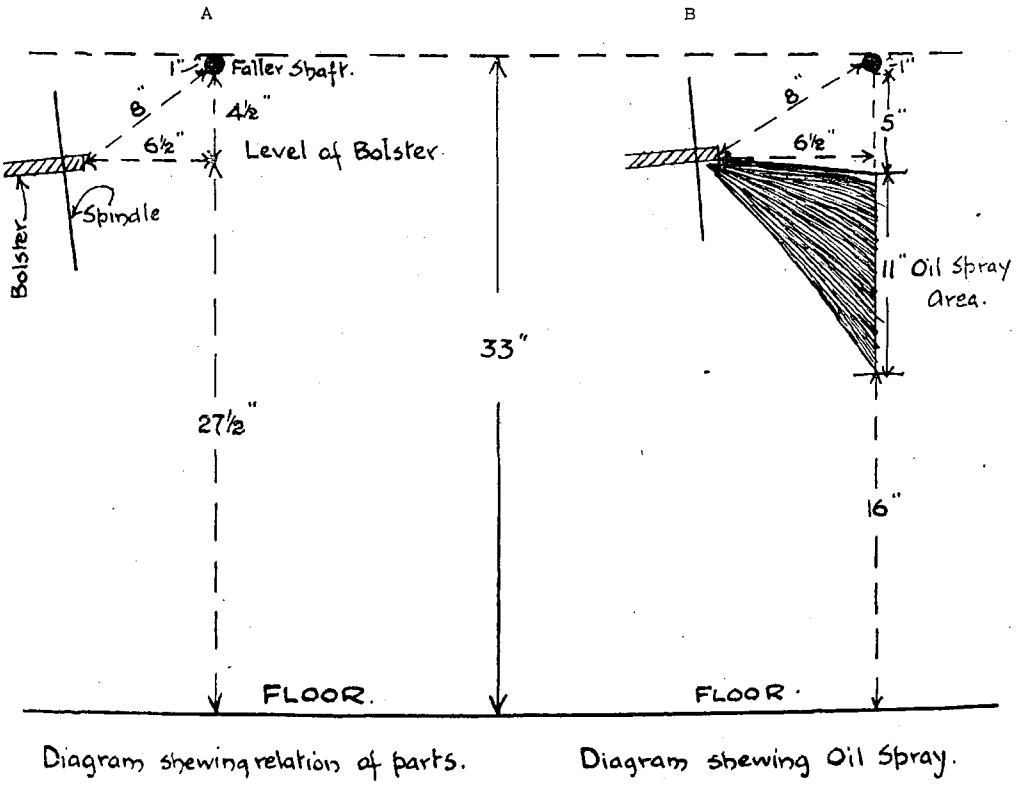


Diagram shewing relation of parts. Diagram shewing Oil Spray.

The carriage travels from and to the Creel over a distance of 64 *inches*, its weight being taken by wheels running on rails on the floor. Its movement may be divided into three phases. Refer Diagram 2.

I. The movement from the Creel occupying 9 *seconds*, during which the cotton is drawn and twisted into thread, the spindles revolving at 9,000 revolutions per minute.

II. A rest of $2\frac{1}{2}$ seconds when a change of gear and action takes place.

III. The return to the Creel occupying $3\frac{1}{2}$ seconds, the thread twisted being now wound on the cops. The spindles are now rotating at 180—200 revolutions per minute only.

The time for one complete movement, or "draw," as it is called, is therefore 15 seconds.

Fixed to the Creel, also about 33 inches above the floor, is a row of small rollers, running the whole length of the Creel, called the delivery rollers, as they deliver the cotton from the bobbins to the cops to be spun. *When a thread breaks, the spinner pieces the broken end directly to these delivery rollers.*

DIAGRAM 2.

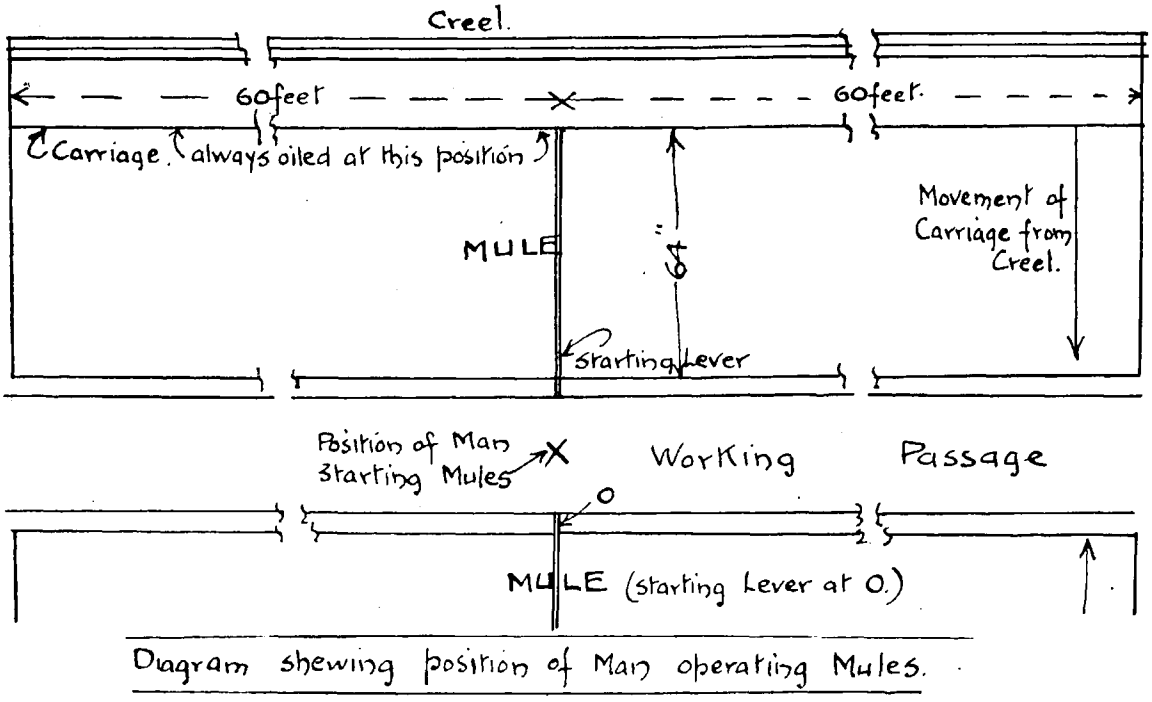


Diagram shewing position of Man operating Mules.

THESIS. PART I.

THE SPINNER AND THE FALLER SHAFT.

It is during the outward movement of the carriage that the spinner leans over the Faller Shaft to piece together the ends of the threads which have broken in the twisting. It is obvious here that he can only do so during the initial part of the movement; he cannot reach anywhere near 64 inches, *as he must piece the broken end direct to the delivery rollers fixed to the Creel.* Any threads missed are pieced on the commencement of the next outward movement. In piecing a thread he takes the broken end nearer him between the fingers and thumb of his left hand, and, standing somewhat sideways with his weight on his left foot, leans over and joins it to the other end on the delivery roller with a quick twist, his right foot being thrown out behind as a counter balance.

POSITION 1.

1

3 4 2

POSITION 2.

1

2

3 4

In so piecing, the spinner may assume one of three attitudes, as represented in the photographs. These attitudes are governed by the position of the Carriage to the Creel at the moment of piecing. The spinner was a man 5ft. 8in. in height, and it is clearly evident that the Scrotum is not, in any of the positions, in contact with the Faller Shaft. In fact, in positions No. 1 and No. 2 the left testicle and its scrotal covering are 2½ inches below the under edge of the Faller Shaft, and in No. 3 the Scrotum is 1¾ inches away from the shaft. This dependent scrotal area on its lower left medial aspect is the usual site of the Epithelioma.

Since writing the above I have read an article by John Brown, M.D., D.P.H., published in the *Medical Times* of January, 1926, of which the following is an extract under the heading "Protection": "Where possible, until mules are suitably designed, employers should employ "long-legged operatives[1]." This, as a protection against the possible friction of the Scrotum on the Faller Shaft, is obviously in complete disagreement with my measurements as given above.

POSITION 3.

3 4

I have watched these men closely when at work, and while the spinner's attention has been fully occupied during the act of piecing, I have slipped my hand along the Shaft and *always* found a space between it and the man. While his overalls might touch the Shaft, being loose, he does not press his body against it, and in any case, as he is leaning over somewhat on his left side, his left thigh is between his testicles and the Shaft, and his testicles are *below* the Shaft. A very small percentage of the men piece with their right hands, and these remarks apply equally to them.

The spinner's movement is necessarily quick; he is making a dive across his machine. His overalls, the only garment he wears, are quite loose and his scrotum is more or less free to swing. The pressure, then, which was supposed to be exerted on his scrotum would not be pressure at all, but more in the nature of a blow. He may perform this movement 240 times in an hour. I cannot conceive of any man impinging his testicles 240 times an hour against a rigid steel rod. Yet this is practically what the present theory suggests.

I, therefore, conclude that friction of the Faller Shaft on the lower end of the scrotum does not take place, and has therefore nothing whatever to do with the causation of Spinners' Scrotal Cancer.

THE OILING OF THE BOLSTER.

The Bolster, as previously stated, is 6½ inches to the inner side of the Faller Shaft and 4½ inches below. It is lined along its upper edge with brass having circular holes. The spindles pass through these holes, their bases resting in small cups known as steps.

No. 1. Oiling Bolster—Carriage Door Closed.

1—Bobbins on Creel.

2—Delivery Rollers on Creel.

3—Faller Shafts.

4—Spindles with cops.

5.—Bolster.

6—Carriage Door.

These cups and the brass on the top of the Bolster are the bearings of the spindles, and it is to these two places that oil is applied to lessen friction. The cups are filled with oil once per week, but are shut off from the rest of the machine and from the worker by wooden doors, which are only opened during the process of oiling. Any oil which might reach the worker by spraying must come from the brass bearings on the top of the Bolster. These are oiled twice a day, once in the morning before starting up, and again after the mid-day halt. The oiling is done *before the mule is started and while the carriage is close to the Creel.* The spinner takes his long-spouted oil can, pours some on the floor to make sure the oil is running clean, then, beginning at one end of the mule and walking along, allows a steady stream to run on to the brass lining where the spindles pass through. This oil soaks into the holes and passes down the spindles.

No. 2. OILING STEPS—CARRIAGE DOOR OPEN.
×—STEPS.

Although the diameter of the spindles is small, nevertheless, the centrifugal force they exert while revolving at 9,000 revolutions per minute is bound to be considerable. Any oil, therefore, which remains on the spindles above their point of contact with the brass lining of the Bolster will be thrown off in the form of a spray. When no oil is there, the spray will naturally cease. It is the extent and duration of this spray which it is now necessary to determine.

EXPERIMENTS SHOWING EXTENT AND DURATION OF OIL SPRAY FROM BOLSTER.

REFER DIAGRAM 1B, PAGE 4.

As Southam and Wilson state in their article[3] that the Faller Shaft is oily and sprayed by the oil thrown off from the spindles, I proceeded to experiment carefully with the machines immediately after oiling. All the experiments detailed were repeated several times in two cotton mills, and also checked at the spinning mule in Blackburn Technical College.

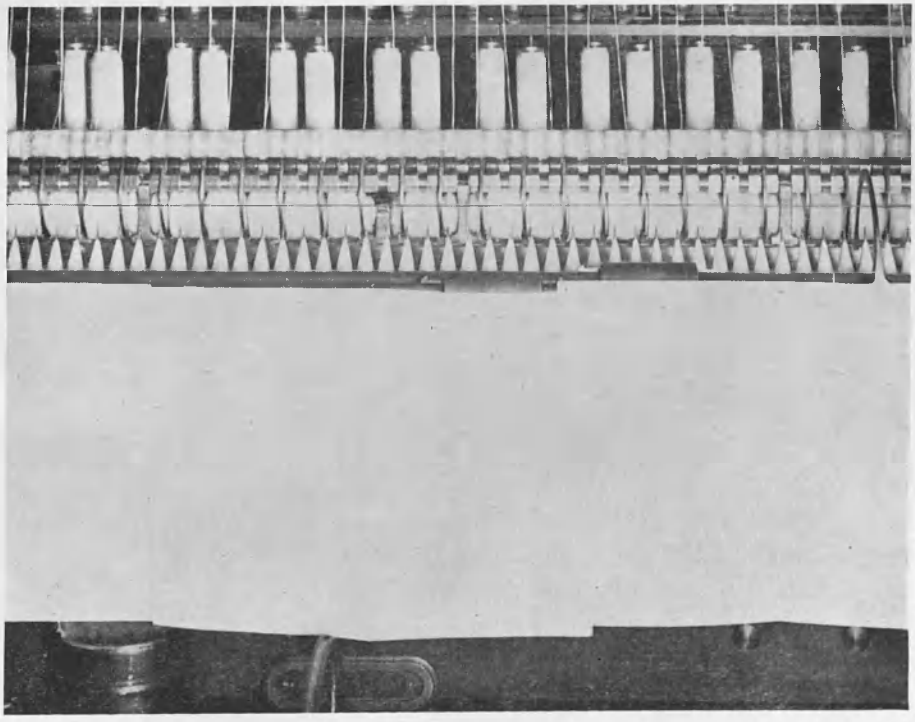
My first three blotting paper experiments (1 to 3) gave negative results, and were carried out as follows :—

I proceeded to No. 1 Mill, about 10-30 a.m. applied a full sheet of blotting paper to the Faller Shaft and left it on the mule for 5 minutes, *i.e.*, 20 draws. Examination : Clean ; no oil. This was repeated at No. 2 Mill at 3 p.m. Result, similar. It was further repeated at the Technical College with a like result. Thereby demonstrating that no oil is thrown off during ordinary working. Examining Faller Shafts in several mills, I found them to be not only free from oil, but showing signs of actual rust.

Each sheet of blotting paper measured 23 inches long, 17½ inches deep.

EXPERIMENT No. 4.

White blotting paper was wrapped round the Faller Shaft and the Bolster oiled. The mule was then started and left working for 5 minutes. The blotters were removed and examined at the end of this period. RESULT : No oil visible, even under a magnifying glass. Chemical test negative to oil.



SHOWING BLOTTING PAPER ATTACHED TO FALLER SHAFT.

BLOTTING PAPER EXPERIMENT—DIAGRAM.

EXPERIMENT No. 5.

Blotting paper was fixed to the Faller Shaft, the several sheets hanging freely downwards as shewn in Diagram, Page 11. A length of shaft of 23 inches was left, so that an intermediate or check experiment could be made.

The Bolster was oiled, the Mule started and run for 5 minutes.

The check blotter was held to the shaft during the fourth and fifth minutes.

The machine was stopped, and the fixed blotters removed for examination.

RESULTS.

THE FIXED BLOTTERS.

I. Oil was found distributed as a fine spray.

II. Small specks of dirt distributed in the same manner as the oil.

III. There was a definite straight line of demarcation five inches below, and parallel to, the Faller Shaft. The greatest density was within $1\frac{1}{2}$ inches of this line. Between this line and the Shaft there was neither dirt nor oil. The oil and dirt spray rapidly thinned in a downward direction, its lowest point being about 11 inches below the line of demarcation.

THE CHECK BLOTTER.

IV. Was clean, showing neither oil nor dirt.

These two experiments prove conclusively that while the spindles do spray, the Faller Shaft receives none of the oil, and that all the oil is off at the end of the first three minutes.

DESCRIPTION OF PHOTO. Page 12.

1.—*Line of Attachment*, represented by the upper edge of the blotting paper, is in line with the axis of the Faller Shaft.

2.—*Line of Demarcation* is upper border of oil spray.

Distance between these lines is 5 *inches*, and represents a clear zone.

3.—*Area of Greatest Density* is 2 inches downwards from line of demarcation.

This photograph was taken to represent the oil spray as thrown off the Bolster after oiling. In order to get such a photo, it was necessary to use a dirty machine, to mix dirt deliberately in the oil and to over-oil the machine. All the oil, even in this experiment, was thrown off in *three seconds*. The amount of oil extracted from the piece of blotting paper here represented was 0.1333 gramme. A photograph could not be taken of a blotting paper result, from ordinary working conditions; the oil distribution, however, was the same and the amount of oil thrown varied from 0.02 to 0.05 gramme.

Natural size of blotting paper shown is 12 inches long, $17\frac{1}{2}$ inches deep.

EXPERIMENT No. 6.

Gives a series of successive one-minute experiments.

In one minute four complete movements of the Carriage take place. Refer page 5.

The Bolster was oiled. I then held a piece of blotting paper against the Faller Shaft during the four "draws," *i.e.*, for one minute. I replaced this by a second piece which I held for a further minute.

RESULT:

All the oil was distributed on the first paper as detailed in the diagram.

No oil was found on the second blotting paper.

EXPERIMENT No. 7.

To determine what happens during each complete movement or "draw," occupying 15 seconds, refer page 5.

The Bolster was oiled. I now held a piece of blotting paper to the Shaft and followed the Carriage during its outward and inward movements. With the help of an assistant I placed a second piece of blotting paper to the same part of the Shaft during the second "draw," and also repeated this to test a third "draw."

RESULT:

All the oil was sprayed upon the first blotter of this series; that is, in 15 seconds.

EXPERIMENT No. 8.

Having oiled the Bolster, with the aid of an assistant, I held a piece of blotting paper to the Faller Shaft during its outward movement, changed it for a clean blotter during the $2\frac{1}{2}$ seconds rest and held this during the inward movement.

RESULT:

All the oil was found upon the first blotter, *i.e.*, sprayed off within nine seconds. Refer page 5.

The second blotter was clean and free from oil.

EXPERIMENT No. 9.

To determine at what point during the nine seconds all the oil is sprayed off.

With the aid of three assistants, one with a stop-watch, the other two holding pieces of blotting paper ready, I had the machine oiled and held a sheet of paper to the Faller Shaft during the first three seconds of the outward movement. No. 1 Assistant immediately took my place with his blotter. He was followed by No. 2 Assistant. This experiment was repeated many times.

RESULT:

All the oil was sprayed off during the first three seconds after oiling.

SUMMARY OF BLOTTING PAPER TEST RESULTS.

After oiling the Bolster in the ordinary course of working, the total amount of oil thrown off upon a piece of blotting paper of exactly the same size as that shown in the diagram was found by chemical determinations to lie between 0.02 gramme and 0.05 gramme.

All the oil is sprayed off during the *first three seconds* of the movement of the Carriage from the Creel. The distribution of the spray in my three-seconds' experiments being exactly similar to that found in all my earlier experiments, and formed a similar picture to that shown in the descriptive diagram.

In three seconds the Carriage has travelled *twenty-one inches from the Creel.* Refer page 5.

EXPERIMENT TO MEASURE THROW OF OIL.

As I desired to find the extreme throw, a dirty machine and dirty oil were again used for this experiment as the dirt thrown off with the oil is easily observable. Two pieces of string were tied to the Faller Shaft 23 inches apart. A piece of blotting paper was held between the strings, the latter being kept taut and level with the Shaft. By this means the distance between the blotting paper and the Shaft was kept constant during any one experiment, and could be varied easily for successive trials. The Bolster was oiled before each trial and the mule set going in the usual way.

The first distance tried was 30 inches and gave no result. By limiting and regulating the distance and repeating the experiments on different parts of the Shaft, the greatest throw was found to be 27 inches from the Bolster or $20\frac{1}{2}$ inches from the Shaft when the blotting paper gave evidence of a few scattered specks of dirt about 11 inches below the level of the Bolster. That is below a man's knees.

STARTING THE MULE.

The starting lever, as will be seen from Diagram 2, Page 5, is placed midway between the two ends of the mule and just outside the radius of movement of the Carriage. When the mule is at rest the belt, which transmits the power from the overhead shaft, is running on a free pulley. When the spinner pulls on his starting lever he is easing the belt from the free pulley to the fixed pulley on the shaft which drives the mule. His movement is not sudden but a steady pull. His machine starts running as soon as the belt obtains a grip, which is practically at once. *The spinner has to keep pulling the lever, however, until the belt is properly on the pulley.*

THE SPINNER AND THE OIL SPRAY.

By means of a stop-watch, and without his knowing that I was doing so, I timed a spinner who was about to start his machine. From the moment he commenced pulling his lever until he left to walk towards the carriage, he took $6\frac{1}{2}$ seconds. I timed a second man from starting the mule until he touched that part of the Faller Shaft nearest to him—his time was 7 seconds. I then asked a spinner to stop his mule with the Carriage at the Creel as usual, and informed him that I was going to time him starting it. From the moment of commencing his pull on the lever until he touched that part of the Faller Shaft nearest to him he took 5 seconds.

I am definitely informed that a "draw" or one complete movement of the mule always takes place after starting up—that is, 15 seconds elapse—before any spinner pieces a broken end, as by the time he gets to the Carriage it is already too far from the Creel, *i.e.*, 35 inches*, to allow of his reaching over to piece. He is, therefore, never in time to receive any of the oil spray, as this has all sprayed off in 3 seconds.

As a further check to this I pinned sheets of blotting paper over the overalls of a number of spinners, in such a way as to cover the lower part of the abdomen, and the upper part of the thighs, and got them to oil their machines and start up in the usual way. RESULT: Negative to oil.

**The Carriage travels outwards at the rate of 7" to one second.*

COMBINED EXPERIMENT.

The mule is stopped, the spinner seen in the photographs, stands against the Faller Shaft, upon which is attached a piece of blotting paper showing the oil and dirt distribution. The height of this man is 5ft. 8ins. as he stands. From the point where the Faller Shaft touches his pubes, to the lowest point of his left scrotum is $2\frac{1}{2}$ inches, that is to say, that his scrotum lies entirely between the line of attachment of the blotting paper and the line of demarcation (that is in the clear zone always found). It, therefore, follows that even if the spinner, after oiling the machine, was standing or bending over the Faller Shaft while another man started the mule, all the oil spray would be thrown upon his overalls, at a level $2\frac{1}{2}$ inches below his scrotum, and the area of the greatest density would, therefore, be 2 inches downwards towards his knees, that is from $2\frac{1}{2}$ inches to 4 inches below his scrotum.

As explained in my previous experiments, however, such a position is never occupied.

I have also demonstrated that, as the spinner leans over the Faller Shaft, his scrotum is $2\frac{1}{2}$ inches below, and $1\frac{3}{4}$ inches distant from such shaft.

SUMMARY.

I. The Faller Shaft exerts no pressure or friction on the scrotum because (*a*) the scrotum is below the level of the shaft. (*b*) The spinner does not lean on the shaft in piecing.

II. Oil is not sprayed on to the Faller Shaft and, therefore, does not get to the spinners' overalls by this means.

III. The oil spray lasts only 3 seconds after each oiling. During this time the spinner is at the starting lever and his overalls receive none of the spray.

I submit, therefore, that no mineral oil is received from the revolving spindles or the Faller Shaft, and no friction from the Faller Shaft is exerted on the Scrotum. These, therefore, cannot be the cause of Spinner's Scrotal Cancer.

THESIS. PART II.

A FURTHER INVESTIGATION OF THE QUESTION OF OIL.

In view of the results of the researches made in the Cancer Experimental Laboratory[2] where it has been shown that medium mineral oils will cause cancer, before exonerating oil from all blame in this particular case or even giving it the benefit of the doubt, it is necessary to proceed to a more intimate investigation. The oil used is a medium oil of 0.9007 sp. gr.

A fact which strikes one on entering the spinning room in a mill is that the floor is wet with oil ; so much is this the case that in old mills it actually drips through to the floor below. Owing to faults in the machinery the spinner often has to kneel on the floor to carry out minor repairs. His overalls thus absorb oil from the floor, at the knees. His hands also become oily, and when the repairs are completed he invariably rubs them dry upon the flanks of his overalls and afterwards finishes the cleansing process with a piece of dry waste.

Four oil areas are thus found upon the overalls, especially at the end of a week's work, viz., one over each knee, one on each thigh, particularly in front of the great trochanters, round the overalls to the middle of the legs and groin in front. A parade of a number of spinners on a Saturday morning in the overalls which they had been wearing since the previous Monday confirmed this. *There was no visible oil and dirt area in the scrotal region ; the most marked areas were over the knees.*

As a further test, arrangements were made with three spinners to start work on a Monday morning with clean overalls lined around the scrotum, groin, lower abdomen, and down the legs to the knees with a piece of absorbent cotton cloth. Two wore blue overalls, and one wore white. These men worked a full week in the usual way and on Saturday morning at 12 noon I received the overalls and linings for examination. On the outside of the scrotal region they felt slightly damp to the touch, but on the inside dry as was also the soft cotton lining in this region. One suit of overalls selected for this test was well worn and frayed around the fork, and even had a small hole in this area about the size of a shilling through which the white lining could be seen.

Two linings and one pair of overalls with lining were taken by me, and delivered direct to Mr. G. W. F. Holroyd, M.A., F.I.C., Head of the Chemical Department, Blackburn Technical College. The overalls and linings were carefully examined by the naked eye and with lenses.

The overalls showed the well-marked four oil areas as described, *but the area against which the scrotum could possibly play appeared free from oil.* Travelling, however, from the oil areas mentioned towards the scrotal area, the cloth suggested an amount of oil capillary movement. As it was unnecessary to make any determinations regarding the overalls as a whole, we confined ourselves to the scrotal area.

For this purpose a central piece was cut out, measuring 6 inches across, and 7 inches down the legs, thereby including all that portion of the overall which could possibly touch any part of the scrotum.

The outer edges of this piece involved a fringe of each oil area, more particularly the flanks.

The weight of this piece of cloth was 7 grammes. (The weight of a new piece of the same material measuring 12″ by 12″ is 22 grammes):

The mineral oil extracted was 0.9008 gramme.

The fatty oil extracted being 0.11 gramme, which latter represented scrotal secretion.

The absorbent linings measured 15 inches by 15 inches, and each weighed 20 grammes.

The linings from the blue overalls gave the following determinations :—

0.2162 gramme, mineral oil.

0.2162 gramme, fatty oil.

The lining from the white overall gave :—

0.1632 gramme, mineral oil.

0.1632 gramme, fatty oil.

From these very definite facts I do suggest that 0.2 gramme of any mineral oil found upon a piece of cloth 15 inches by 15 inches at the end of one week's work, cannot have any influence upon the production of an Epithelioma.

The naked eye examinations of these linings showed that any suspicion of oil was limited to the outer edges ; centrally, and where the scrotum played, the linings were faintly stained yellow, and this we take to represent the fatty oil secreted from the scrotum. Reviewing these several facts, I am of opinion that all the oil is received upon the overalls first from the floor, and second from the hands of the spinner, which in turn received the oil from the floor.

This is a daily increasing quantity, commencing in four limited areas, and from these spread by capillary attraction in all directions. This spread, however, does not reach the very limited area of the overall which plays upon the very definite sites occupied by Spinner's Epithelioma Scroti.

The spinner works in his bare feet on this oily floor, his feet are oily and his socks are definitely oily. I have found no spinner who washes his feet oftener than once in two weeks. From the time he leaves his work until he returns he has the friction of his socks and boots or clogs upon his oily feet, yet never suffers from cancer of the feet or even sores. The skin of his feet is soft and healthy. Spills of wood from the floor get into the soles of the feet ; they are removed and the wounds—painted with iodine—rarely even suppurate.

CAPILLARITY EXPERIMENT

As stated, 0.9 gramme of oil was extracted from that piece of overall cut out at the end of one week's work of 5½ days. This oil was found around the outer edges. It is further noted that not more than 0.2 gramme of oil penetrated through the overalls to the 15″ by 15″ piece of absorbent cotton, also worn for the said 5½ days; and this oil too was confined to the four corners which came in direct contact with the four receiving oil areas.

I now desired to study the capillary movement of this oil.

For this purpose I took two pieces of overall cloth, each measuring 6″ by 7″, one piece new, one piece washed and dried.

Eight corks were fixed to a board, upon which these two pieces of cloth were fixed.

Four edges were marked off, to represent the areas of contact with the overall working conditions as described on page 17.

0.9 Gramme of machine oil as used at the mills was placed in a burette, and its drop value estimated. From the burette used this equalled 43 burette drops.

A 5½ days' experiment was now carried out so as to represent as near as possible working conditions. The two upper outer edges to represent the oil areas on the thighs. The lower edge to represent oil on the knees.

The oil was added as follows:—

	NO. OF DROPS.		
	THIGHS.		KNEES.
1st day	3	3	4
2nd ,, ...	4	4	3
3rd ,, ...	3	3	4
4th ,, ...	4	4	4
	14	14	15 = 43 drops = 0.9 gramme.

At the end of 5½ days the capillary movement on new cloth = 4.25 c.m.

,, ,, ,, ,, ,, ,, ,, washed ,, = 3.0 c.m.

The area of cloth which would act upon the scrotum, and particularly upon the sites of this disease, remained free from any oil.

These experiments were carried out at the Darwen Secondary and Technical Schools, were observed by, and all measurements were carefully checked by, J. Foulds, A.R.C.S., F.I.C., and A. Holderness, M.Sc.

Taking all the facts, it can be definitely stated that no oil reaches the scrotum, and therefore cannot be a factor in the causation of Spinners' Scrotal Epithelioma.

THESIS. PART III.

The two usual sites of this disease are very definite and limited. They are situated upon (*a*) the inner lower medial side of the left half of the scrotum, (*b*) the medial lower edge of the right, as shown in diagram, page 23.

This very limited area as a site of disease, especially arising upon a skin surface which is generally equally susceptible, forces the conclusion that some very specific operating factor or factors must be at play. Such factors must be peculiar to the spinner, his clothing and his movements.

Examination of the spinner shows that he is not particularly clean as to his person. I have examined several hundred and have in all cases found the scrotum sticky and dirty. Working in a hot and—contrary to the usual conception[9]—somewhat dry atmosphere and drinking on the average one pint of water per hour, he perspires freely. His overalls being thin, absorb little of this. Evaporation results in a concentration of dirt and salts on the skin. The scrotum, a dependent organ, whose corrugated skin lends itself particularly to the retention of dirt, possibly receives more than its share through gravitation.

There is no reason to suppose that the spinner of to-day is any dirtier than his forbears. While the dirty scrotum, the mineral oil, and the same movements required of the man, have existed since 1880, scrotal cancer has only lately become serious as the following statistics disclose. It would seem, therefore, that it is necessary to find some recent factor or factors operating upon the scrotum, and on a definite part of it.

STATISTICS.

Cases operated upon at MANCHESTER ROYAL INFIRMARY from 1902 to 1921. Total, 69. 84% Left, 16% Right or Central. No other details available.

1922	5 cases	All left sites.
1923	6 cases	
1924	5 cases	

BLACKBURN ROYAL INFIRMARY.

1900	Nil.	Brought forward ..	19
1901	1	1913	1
1902	1	1914	1
1903	1	1915	2
1904	1	1916	1
1905	1	1917	4
1906	1	1918	Nil.
1907	1	1919	5
1908	1	1920	3
1909	1	1921	5
1910	4	1922	3
1911	4	1923	6
1912	2	1924	2
Carried forward ..	19	Total	52

BOLTON INFIRMARY.

First records, 1920.

1920	1	All left sites.
1921	4	
1922	8	
1923	6	
1924	10	
(To September) 1925	5	

RECORDS OF CASES COLLECTED BY THE ASSOCIATION OF OPERATIVE SPINNERS.

Year.	No.	No. Died since onset.	No. Died each year.
1917	12	8	2
1918	17	9	7
1919	9	3	5
1920	11	6	6
1921	16	9	2
1922	25	10	8
1923	26	11	14
1924	57	13	21
1925	—	—	(to March) 4
Totals...	173	69	69

Average age of onset, 52 years.
Average age at death, 53 years.

A few cases of Spinner's Scrotal Cancer can be traced back to 1900, but it was not until after the war that attention was directed to this disease because of its rapid increase. In 1922 the Home Office made it notifiable under the Factory Act.

STATISTICS.

The following information, regarding Spinner's Scrotal Cancer, was supplied to me by the Factory Department, Home Office.

	Year 1923.	Year 1924.	Year 1925.	Total.
No. of Cases Notified	14	57	54	125
No. of Deaths	1	13	28	42

Total Number of Mule Spinners = 23,000.

From 1880 until about 1905, spinners wore white overalls. The cloth of which these overalls were made, called "Fustian," was of a soft, kindly, nature, and contained no chemicals. Blue overalls began to make their appearance at this period the cloth being a hard cheap material containing about 25% to 40% size (magnesium chloride, zinc chloride, and sago). Another kind of white cloth also, began to be worn at this time, differing from the blue only in the absence of colouring matter.

The older men, accustomed to the soft white Fustian, continued to wear it, the younger men wearing the cheaper material. Thus the blue overalls began gradually to displace the others until 1914, when some 90% of spinners were wearing blue, the remainder wearing the cheap white. The soft Fustian overall is now practically unknown.

Oil, dirt, and all movements performed by the spinner, being constant factors throughout the history of the trade, it is necessary to find other factors to explain the increase in the incidence of this disease. I suggest that the history of the present type of overall is the history of the increase in the number of spinners suffering from this disease. The statistics given in conjunction with what is known of the time required for the development of the disease, bear out this suggestion[2].

The spinner has two pairs of overalls in use at a time, the pair he is wearing and a pair at the wash. Every Saturday he takes home to be washed the dirty pair which he has been wearing all week and appears every Monday morning with a clean pair. One pair is generally fairly new and the other fairly old, and the men, on examination, are found to be stained around the scrotum, and down the legs with blue dye[5]. A pair of overalls generally lasts about 18 weeks.

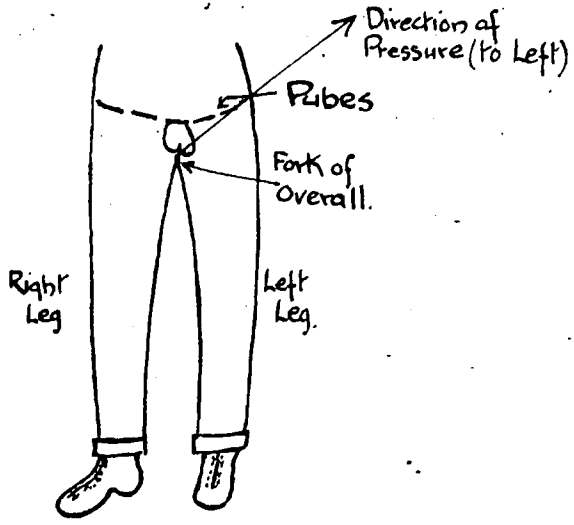
The overalls are worn next the skin. They are held up by means of *cloth straps of the same material*, sewn on at the back and coming over the shoulders to button in front. In the piecing movement the stretching out of the left arm and consequent raising of the left shoulder, pull on the loosely-worn overalls and cause slight pressure and friction on the *very points of the scrotum* on which the Epithelioma is usually found.

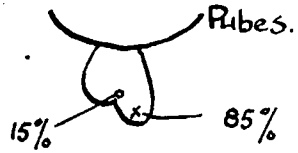
The study of the detail occurring during the movement of a spinner while piecing is very interesting. The right testicle is situated at a higher level than the left, and while spinners are usually dressed to the left in their overalls, as men commonly are, the fork of the overalls is in such a position, that when the spinner reaches over the Faller Shaft the right testicle immediately passes slightly upwards and backwards, the left testicle remains in its lower position. The fork of the overalls passes between the testicles thereby causing pressure upon the scrotum in a direction obliquely upwards and outwards to the left.

Diagram, illustrating this matter, see next page.

It will also be seen that the inner side of the overall leg presses against the medial side of the left scrotal pouch containing the left testicle ; *this is the usual situation of the Epithelioma. These rapid intermittent frictions, some* 240 *per minute, acting upon a dirty scrotum plus the aniline dye is I suggest the cause of this disease*[6].

In a large number of mills women have always been employed at mule spinning, and during the war their number was much increased. They wear a blue cotton skirt with an under-petticoat only. They have the same duties to perform as a male mule spinner, yet I can find no case of labial cancer recorded. Amongst worsted spinners, who use a mule similar to that used in cotton spinning, the oiling of the Bolster is carried out in a similar way, and the oil used is a mineral oil, 0.9007 sp. gr., the same oil as is used in cotton spinning. The wool spinner leans over the Faller Shaft to piece his ends, just as the cotton spinner does. I can find no case of wool spinners' scrotal cancer, except one case reported to the Home Office in 1924. I further enquired at a large firm of wool spinners, Messrs. Paton and Baldwin, and am definitely informed that they know of no case arising amongst their spinners, and they have been in business for over 60 years. *Wool spinners wear their overalls over an undergarment, and this is, in my opinion, a vital factor.*





The Fine Cotton Spinners' Association, Manchester, have made specific enquiries, at my request, in regard to the conditions obtaining in France.

I submitted a list of questions and, in reply thereto, I am definitely informed from Lille, France, that :—

I. No cases of Epithelioma of the Scrotum are known amongst the French Spinners.

II. The spinning mules and working conditions are similar to those obtaining in Lancashire.

III. The spinners wear blue, white, or black overalls of the same material as worn in Lancashire, upon their bare legs, and they work in bare feet.

IV. They are subject to the same oil conditions as is the case in Lancashire.

V. *They do not wear shoulder straps, their overalls are supported by a waist belt.*

These factors further support my argument and experimental proofs, that this disease is not due to conditions within the mill, but due to the friction (plus the scrotal state) resulting from the shoulder pull upon an inelastic brace, causing the overall fork to operate upon the Scrotum as already described. In France the waist belt supports the overalls, so that when the spinner leans over the Faller Shaft in order to piece the cotton—the shoulder being free—*there is no pull upon the overalls, and therefore no friction of the overall upon the Scrotum at any point.* The wool spinner, as already stated, has the protection of a soft undergarment.

During my investigations, I have seen 29 cases who have been operated upon for this disease, 28 wore blue overalls, one wore white, all had the disease at the usual site on the left side of the scrotum.

All the figures given are very definite proof that this disease is rapidly increasing amongst male mule spinners, and I am now, after my experimental work, strongly of opinion that the spinner should wear the white Fustian overall supported by an elastic brace, or if he wears the blue or hard white overall, he should have next his skin, some short undergarment of soft material, and should wear *an elastic brace or a waist belt.* Cleanliness of the scrotum is also required of him. By these means, I feel sure that this disease would seldom be seen. Further, I suggest, as I have definitely proved that all the oil found upon his overalls is received from the floor, the spinning-room floor should be washed at least every two years, and this would prevent any accumulation of oil.

PATHOLOGY.

One of the 29 cases, which I examined, had in my opinion an early recurrence of the disease. A small white scaly patch was observable situated near the mid line anteriorly and at the most dependent part of the right side of the scrotum, just in line with and near to the scar of his previous operation. This patch was hard to the touch and in its centre was seen the opening of a skin gland. I picked off this scale, and found a raw looking surface which easily bled.

The man informed me, that because of the itching and tingling sensations from which he suffered at the commencement of his previous epithelioma, he also picked the scale off, after which, on several occasions, a little blood came away.

All the cases I saw experienced these sensations.

CONCLUSIONS.

Spinner's Scrotal Epithelioma is not caused by oil spray thrown by the working mule, neither does the Faller Shaft take any part in its causation.

The oil found upon the spinner's overalls is absorbed entirely from the spinning room floor, and gradually spreads by capillarity from the four receiving areas, but does not reach by the end of $5\frac{1}{2}$ days the circumscribed area of the overall which operates upon the scrotum at the definite site of this disease as found amongst spinners.

The definite aetiological factors in my opinion are the dirty scrotum, the added factor of the dye, and the friction from the hard rough and unkindly cloth *especially* at the fork of the overalls which contains the rough made seam, acting very definitely upon the exact scrotal situation where this disease is *always* found, this friction being aggravated by the use of an inelastic brace.

My findings, therefore, raise the question, is this disease one which "arises out of and in the course of the employment?"

I am advised that on my findings, this disease would not be held to so arise, but rather that it falls within that class of case of which the following may be cited as examples :—

(1) DENNIS v. MIDLAND RAILWAY CO. (H. of L. 1921).

> Engine-driver, called late for work, left home insufficiently clad and without food, whilst driving engine contracted chill and died of pneumonia—Did not arise in course of employment, but at man's home[7].

(2). HANNIFIN v. FITZMAURICE (I.C.A. 1921).

> Domestic servant, in course of duties, was walking across kitchen and fell owing to one of her shoes coming off (the heel being worn down).—Was not entitled to compensation[8].

In the earlier case the condition was caused by this man's weak physical condition caused by his use of unsuitable clothing for his work or rather his failure to use suitable and adequate protection for his occupation ; the case of number two is one where the imperfect clothing worn constituted the cause of accident.

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N. Leach, Typo., Darwen.