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EFFECT OF THE AIR HAMMER
ON THE HANDS OF STONECUTTERS



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EFFECT OF THE AIR HAMMER ON THE HANDS OF STONECUTTERS.

INTRODUCTION.

This bulletin contains reports of studies as to the effects of the use of the pneumatic chisel upon stonecutters, made by the United States Bureau of Labor Statistics and the United States Public Health Service, together with statements by physicians employed by the workmen and the employers. The Bureau of Labor Statistics undertook this study by reason of the statements made by the president of the Journeymen Stone Cutters' Association of North America and at the request of the American Association for Labor Legislation.

At first this inquiry was limited to the stonecutters of the limestone belt of Indiana, as it was alleged that they are the only users of pneumatic tools who suffer serious effects from such use. Two agents of the bureau were sent to the Indiana limestone belt and secured statements from both employers and employees as to the effects of the air hammer on those using it. The bureau also secured from Dr. C. E. Cottingham, who was employed by the Journeymen Stone Cutters' Association, a report of his observations upon seven men. The statements of the men and of the employers were so at variance that I was unwilling to publish these statements without further investigation. Dr. Cottingham's findings were especially disturbing and, if corroborated by further study, would have made it necessary at least to control the use of the air hammer in the soft stone industry by legislation if not to abolish its use altogether.

Accordingly, I sent Alice Hamilton, M. D., to Indiana to make physical and medical examinations of the men who were said to be suffering nervous and other disorders from using the air hammer. Dr. Hamilton first visited Bedford and Bloomington, Ind., in April, 1917, examined some of the men, and made a first report. She recommended that she be permitted to make a second visit during the cold weather when the hands of the stonecutters show most plainly the disturbance of the circulation of the blood and the sensitiveness

of the nerves. She therefore made a second visit in January and February, 1918. In the meantime my attention was called to the granite cutters of Quincy, Mass., and Barre, Vt., and to the marble cutters of Proctor, Vt., Long Island City, N. Y., and Baltimore, Md. The employers stated that the men working on granite and marble suffered none of the ill effects from using pneumatic tools that were alleged by the cutters of the soft limestones. The granite cutters, on the other hand, stated very positively that they did suffer from "dead fingers." Accordingly, I instructed Dr. Hamilton to visit the granite and marble centers to ascertain what the conditions are and to include these trades in her final report.

Some letters were received by me from employers manufacturing sandstone in Ohio and Missouri, stating that their industry would be seriously injured if the use of the air hammer were abolished by law. Further inquiry disclosed that the workmen using the air hammer in working sandstone were little affected thereby because the tool was seldom used and then for only short periods.

Dr. Hamilton's final report will be found on pages 53 to 66 below.

During her second visit to Indiana, Dr. Hamilton arranged to have eight stonecutters go to Chicago for observation and tests of sensation to heat, cold, touch, and pain. These tests were made by Dr. Thor Rothstein, professor of nervous and mental diseases of Rush Medical College in the Presbyterian Hospital in Chicago. Dr. Rothstein's thorough and careful study extending over several weeks throws much new light on the subject. Because of the long period during which Dr. Rothstein kept the men under observation and the thoroughness of the tests he applied, his report is especially valuable and his findings of fact will be accepted as authoritative.

Having learned that several soldiers stationed at Camp Shelby, Miss., were stonecutters from the Bedford, Ind., district, and that they were said to suffer from "dead fingers," I communicated with the War Department, and in due course received a report from Maj. N. A. Cary, of the Army Medical Corps, on the physical condition of eight former stonecutters stationed at that camp. Maj. Cary's report will be found on pages 97 to 99.

In January, 1918, the Public Health Service made an investigation of the health hazards to stonecutters in the Indiana limestone belt entirely independent of the Bureau of Labor Statistics studies. The report made by J. P. Leake, passed assistant surgeon, and David L. Edsall, M. D., are included in this bulletin by courtesy of the Public Health Service.

It is to be noted that the findings of all the physicians employed by the Bureau of Labor Statistics, the Public Health Service, and the

United States Army are in almost perfect agreement as to the nature and extent of the disability suffered by the users of the air hammer. The disorder is disagreeable and troublesome in cold weather, but is not dangerous, and it does not seriously discommode the worker from pursuing his calling. It may, however, prevent the stonemason from taking up an occupation requiring some delicacy of the sense of touch or accuracy in the use of his fingers.

It is very desirable and entirely feasible to make changes in the design of the air hammer and the cutting tools used so that the workman may continue to use air power in cutting stone without suffering any of the bad effects that usually result from working with the type of air hammer now used. The suggested improvements in the design of the pneumatic chisel would be good economy, for the efficiency of the stone-cutter is considerably impaired by "dead fingers." What is more important, the elimination of a painful occupational disease would make for more contented workmen. A disproportionate amount of time and talent has been expended upon the study of "dead fingers," a relatively harmless occupational disease. It is to be hoped that one incidental result from these investigations will be the centering of public attention upon the most deadly hazard in the stonemasonry occupations—namely, tuberculosis.

Part III of the bulletin is taken up with the reports of the physician employed by the Journeymen Stone Cutters' Association and three physicians reporting on behalf of the employers of Bedford, Ind., Proctor, Vt., and Baltimore, Md.

ROYAL MEEKER,
United States Commissioner of Labor Statistics.

PART I.—PRELIMINARY INVESTIGATION BY THE BUREAU OF LABOR STATISTICS.

SUMMARY.

STATEMENTS AS TO EFFECT OF USE OF AIR HAMMER.

STATEMENTS BY EMPLOYEES.

The employees' testimony is, for the most part, confined to describing the various detrimental effects of the air hammer upon their health.

Employees say that a number of ills—numbness in one or both hands or arms, loss of sleep, nervousness, limbs "going to sleep," headache, pain in various parts of the body, heart trouble, and tuberculosis—are produced by the constant use of the hammer for any considerable period. They admit that sometimes the condition is improved somewhat by the cutter's stopping work for a time or taking up some other occupation, but say that in many cases work with the machine unfits the stonecutter for other employment because it leaves the hands stiff, cramped, and numb. The workmen assert that the employers insist on the use of the device and usually do not allow its alternation with the mallet and chisel, that they refuse the men a hearing on the evils resulting from work with the machine, and threaten a lockout if the use of the hammer is not continued. The men say that no ill effects were felt from the work of stonecutting until the air hammer came into use, and that upon return to the hand method the general health often improves. Some stonecutters say that they prefer the pneumatic tool, but think its use should be regulated and occasional use of hand tools allowed.

According to officials of the Journeymen Stone Cutters' Association, to which most of the men belong, the effects of the use of the hammer are worse in working with soft materials, like limestone, than with hard substances, like iron and marble. They state that in Germany the results of work with the air hammer are recognized as so deleterious that the device has been "legislated out" of the country.¹

¹ Thorough search by investigators of the Bureau of Labor Statistics failed to disclose any legislation like that here mentioned.

STATEMENTS BY EMPLOYERS.

The employers' opposition to the abolition of the air hammer is based on the grounds enumerated below:

The employers declare that no case is known of permanent disability, paralysis, or insanity traceable to the use of the air hammer. They admit that continued employment of the hammer does apparently disturb the circulation of the blood and cause numbness, particularly in the left hand, but claim that this condition has also been caused by the continued use of the mallet and chisel and can not be attributed to the new contrivance. Employers say that if the use of the hammer itself were harmful to the operator, the right hand, which holds the hammer, would be affected instead of the left, which holds the tool, as is usually the case.

According to them, any harmful effects on the health of the cutter are due to the abuse of the air hammer. They say that the pointing and roughing should be done with the hand tools, but that because more energy is required by the hand method, the cutter continues to use the pneumatic hammer. Regulation of the weight of the blow delivered, by placing the finger or thumb over the exhaust, is regarded by the employers as a misuse of the machine, as there is a stopcock on the pipe near the hammer for this purpose. The employing firms assert that the hammer, properly used, blows the dust away from the workman, that it is really a help, and that the men prefer using it to the old way. The fact that the tool is cold, which is charged as one of the causes of the numbness complained of, is admitted, but they state that the experiment of heating the air is to be tried, and that any other remedy for the fault will be welcomed.

Employers point out that if the complaints of the workmen against the hammer are well founded, it is strange that no opposition has been manifested among the structural-iron workers and others who use similar hammers, and draw the conclusion that the object of the complaint is to make the work appear difficult and hazardous and so to force an increase in wages. They draw attention to the fact that general conditions in the trade are good, and that all establishments are "practically inclosed," in contrast to conditions prevailing in structural-iron work, in which the employee is exposed to all kinds of weather.

The firms contend that the opposition shown is due to the reluctance of the workman to use a new method and to the fear of labor—an ungrounded fear in this case—of fewer positions as a result of the introduction of labor-saving machinery. They maintain that under present conditions the hammer is necessary to the trade, because by its use stone is produced more cheaply and therefore can be sold more cheaply than by the hand method; and the industry is thereby

enabled to hold its own in the competition with artificial stone and terra cotta. They assert, finally, that the "reform," if there is to be any, must come from the employees, as the employers are helpless in the matter.

DESCRIPTION OF AIR HAMMER.

The air hammer, about which complaint is made, is used in connection with the cutting and preparation of stone and is similar to the one employed in riveting in structural-iron work, shipbuilding, etc., except that it is adapted to stonecutting tools. In structural-iron work the tool is not held in the hand but is inserted in the hammer, both hands holding the hammer. It is held against the hot rivet for only a fraction of a minute at a time, the hand being released while the hammer is being shifted or while the workman is waiting for another rivet to be inserted. In stonecutting work the use of the hammer is nearly continuous and the tool must be held in the left hand and carefully guided by the pressure of the fingers. The structural-iron riveters work in pairs and spell each other, so that, counting the pauses, no one man is actually using the hammer more than three out of the eight hours of the day. Moreover the hammer used is much heavier and part of the vibration is taken up by the weight. The piston is long and does not deliver many strokes a second—only about 24 or 25—while the stonecutters' hammer has a short piston and is said to deliver from 3,000 to 3,400 strokes a minute, with a pressure of 80 to 90 pounds. There is therefore little similarity between the two kinds of work even if a pneumatic hammer is used in each. The air for the hammer is heated in a few of the Bedford mills in order to prevent "choking" by little particles of ice which form in the pipe leading to the hammer, but the air which issues from the exhaust is always cold in spite of this heating.

In the operation of the device, the tool which fits into the hammer is held and guided by the left hand, while the hammer is held in the right hand, the thumb or index finger sometimes controlling the exhaust. This method is said to be contrary to good usage, though it is quite common. A valve in the pipe below the hammer is supposed to be the proper controlling mechanism. There are various sizes of air hammers in use in the different branches of the trade. In limestone cutting those most commonly employed are the $\frac{3}{4}$ -inch and 1 inch sizes. However, in some mills they have in addition the $\frac{5}{8}$ -inch, the $\frac{7}{8}$ -inch, and the $1\frac{1}{2}$ -inch hammer. The 1-inch hammer, which is recommended by the manufacturer when only one machine is installed, has a stroke of about 3,000 blows to the minute under a pressure of 80 to 90 pounds.

Several kinds of tools are used in these hammers. The principal ones are the $\frac{1}{2}$ -inch chisel, the 1-inch tooth chisel, the $2\frac{1}{2}$ -inch tooth chisel, the splitter, and droves of various sizes. The tools most frequently used in the hammer for pointing and knocking off the rough are the splitter and the "go-devil," a two-tooth chisel. The air hammer and the tools used in connection with it are furnished by the employer. In marble work $\frac{1}{2}$ -inch, $\frac{3}{8}$ -inch, and $\frac{3}{4}$ -inch hammers are chiefly used. Granite cutters have, in addition to the various sizes of air hammers, two other pneumatic tools, the sur-facer and the "bull-set" or "four-point." Both are used in preparing the surface of the granite and both differ from the air hammer in that they are held perpendicularly with both hands grasping the handle—the tool is short and can not be held in the left hand. They therefore resemble the riveters' hammer and not the one that is the subject of the present study.

There are certain hand tools still in use, such as the hand hammer, the pitching tool, the hammer points, mallet, and mallet-head points. These tools are furnished by the stonecutter and are intended to pitch the rough stone to the marked line and point off the rough.

ORIGIN OF THE STUDY.

As stated above, the attention of the bureau was drawn to a dispute between the employers and the employees in the Indiana oolitic limestone belt through a speech delivered on December 28, 1916, at Columbus, Ohio, before the American Association for Labor Legislation, by Mr. Sam Griggs, president of the Journeymen Stone Cutters' Association of North America. This address contained specific charges as to the injurious effects of the air hammer on the health of the stonecutters.

Mr. Griggs's speech was as follows:

I represent a labor organization, the stonecutters' union, and I am very sorry that there are not more of us here this afternoon. Of course we are affiliated with the American Federation of Labor, and in a measure the federation is opposed to compulsory insurance. We came here to-day to investigate, to learn something, and probably to do away with the opposition we have had toward compulsory insurance.

The stonecutter is a migratory sort of fellow, and I don't know how he will fit into your scheme of insurance. He may be working to-day for one contractor and to-morrow he may be out of a job, and several days afterwards he may be four or five hundred miles away looking for another job under another contractor. It is, as I understand it, not necessary for him, under the proposed bill, to go through a physical examination. Physical examination would be especially serious in our line of business if required. We are subject, as an occupational disease, to tuberculosis. Most of our men are more or less afflicted with it through the nature of their calling. They work on sandstone, and the small particles of sand underneath the chisel rise, are inhaled, and settle on the lungs and tuberculosis follows.

There has been no attempt upon the part of the employers to help us in any way to take care of the men when they become afflicted with tuberculosis. The men are absolutely powerless to help themselves. For that reason, too, I came down here to learn about your plan, to see if it would help us in any way to take care of them.

I have another little thing here that I want to bring to your attention. I heard one of the employers this morning say that they should not be hurried in regard to health insurance, that they don't want to have it thrust upon them too fast. Anything that the employers conceive, however, they don't hesitate a moment to thrust upon the workingmen. They are now pushing this efficiency movement you have heard so much about from Mr. Taylor and others. Here is a tool in our business they call an efficient one. [Shows tool.] It was gotten up by an efficiency expert. It is a pneumatic tool, superseding the old-fashioned mallet and chisel. On this end is a heavy rubber hose, and they run it with 80 to 100 pounds' pressure. This tool has an inch stroke and it strikes 3,400 blows every minute. The incessant vibration soon starts to paralyze the hands of a man who cuts stone with it. First it affects the left hand till it reaches the elbow, then it starts on the other hand. When a man gets up in the morning his fingers are bent double and he has to pull them out forcibly and go through a violent exercise until he gets some circulation into them. We had a case where the disease attacked the spinal cord and made a man violently insane. He was a perfect specimen of manhood, 37 years old, and he laughed when the doctor told him that if he did not quit using this efficiency expert's device he would go insane. But he went insane, as the doctor predicted, and a short while later he died.

This tool is an inhuman thing. We have tried every way possible to have the employers investigate the results of using it. Recently we have had a controversy with the employers over the use of this tool—some of them are bigger than this—and they told us that when the local agreement in our district expires on the 12th day of next month, if we refuse to use this tool, no matter what the result may be to our physical well-being, they will lock us out under the terms of the agreement with our international union.

I am glad that Dr. Andrews invited us to come here to-day, and we have been glad to bring this device with us and try to show you what effect it has on the men.

In Germany, under health insurance, this hammer was four or five years ago legislated out of the country entirely. One reason was because it affected a man's efficiency. As experts they did away with it entirely and would not allow it to be used. When the time comes they will do away with it in this country, not for military purposes, but for health purposes.

As a result of this speech, the American Association for Labor Legislation, at its annual business meeting on December 29, 1916, passed the resolution given below:

Whereas representatives of the stonemasons' organization have presented to this meeting of the association evidence of the injurious occupational effects of dust and of the pneumatic tools of their industry, resulting in tuberculosis and paralysis.

Resolved, That the United States Bureau of Labor Statistics be urgently requested by this association to make a thorough investigation of these conditions and their effects on the workers and to report upon the same at as early a date as possible within the ensuing year.

Request made of the Journeymen Stone Cutters' Association, by Dr. Hamilton, for information in regard to the disease mentioned as being contracted by stonecutters, brought a reply from the general secretary of the union which is of interest here in that it summarizes the attitude of that association on the air-hammer question. The letter is as follows:

INDIANAPOLIS, IND., *April 18, 1917.*

MY DEAR DR. HAMILTON: I am just in receipt of your valued favor of the 16th instant and I am pleased to learn that Dr. Joseph Miller, of Chicago, has written you concerning the peculiar disease suffered by our members who use the pneumatic, or air, hammer in the cutting of stone, and that you are sufficiently interested in the matter to consider making an investigation.

During the last 10 years, the pneumatic, or air, hammer has been introduced into our trade as an efficiency tool, supplanting the mallet and hammer as heretofore used by the stonecutter, and to-day its use is universal in what is known as the Indiana oolitic stone belt, comprising the cities of Stinesville, Ellettsville, Bloomington, and Bedford, Ind., and while many of our members refuse to use this tool owing to its detrimental effects upon their physical well-being, the employers in the Indiana belt deny employment to such men as will use only the tools of their trade, the mallet and hand hammer.

This tool has been gradually introduced into the trade, and it is of very recent years that mechanics have been compelled to use it for all stonecutting, or throughout the entire working-day of eight hours. Prior to its universal installation in the Indiana stone belt, the mechanic used the tool on light work or for cleaning-up purposes, which afforded him an opportunity to escape in a measure its inhuman effects, as he could rest his nerves and muscles by using the mallet or hand hammer in the interim. However, the employers seemed to have no regard whatever for humanitarian restrictions on the use of this tool, and eventually forced all employees to use it constantly throughout the entire eight-hour day. If the employee was found resting, or in a measure protecting himself by laying down the air hammer and using his mallet or hand hammer, he invariably was paid off and his services dispensed with, and while he was not advised that his refusal to use the air hammer continually was the cause of his discharge the evidence was too plain to deny it.

During the past five years hundreds of complaints have reached this office of the detrimental effects of the continued use of this tool. Many of our local unions throughout the country have refused to use the tools at all, and as a result are not at this time using them. In these cities the stand taken by our local unions was possible, owing to the fact that the air hammers had not previously been universally installed.

The officers of this association have on several occasions, in meeting with the Cut Stone Contractors' Association, of which most all operators in the Indiana stone belt are members, submitted this question of the air hammer and its ruinous physical effects and requested that something be done to remedy the evil.

The employers have treated this subject very lightly—I might say almost with contempt; in fact, during recent negotiations for a new wage scale in the Indiana belt they flatly refused to meet with the men if they insisted on

submitting this air-hammer question and discussing the same. This in itself would convince one that they proposed to use this tool in their shops irrespective of whether it ruined the health of their employees, treating their employees in the same manner as they would a horse or a mule, possibly with the satisfaction to themselves of being able to get another stonecutter when they had worked one into physical ruin.

In order that we might interest the general public in this inhuman tool, Mr. Griggs, president of the association, and myself attended the convention of the American Association for Labor Legislation held in Columbus, Ohio, December 28, and laid this question before them. The result was that the American Association for Labor Legislation passed a resolution calling upon the Department of Labor to make an investigation of this tool and its effects upon men who used it in the Indiana stone belt. The United States Department of Labor did make such an investigation, Special Agents Harry L. Smith and Paul H. Moncure spending some three weeks in Indiana stone fields, questioning the men who had been using this tool. These gentlemen were in a manner handicapped by the fact that the stonecutters in the Indiana field were a little reticent about making statements, fearing, as it was quite natural for them to do, that they would later be objects of discrimination, if not blacklisted, by the employers. At any rate, Messrs. Smith and Moncure collected considerable data, and I learned recently upon the occasion of a visit to the offices of the Department of Labor at Washington that their report had been filed with the chief clerk.

We agreed with Messrs. Smith and Moncure, when they called at this office, to submit some of our members who had been using this tool to a specialist for examination and a complete diagnosis of their physical condition. Accordingly we took the matter up with a surgeon here in Indianapolis, and he referred us to a nerve specialist, a Dr. Cottingham. We submitted some seven men to him for examination, ranging in age from 22 years to nearly 60. Four of these men he examined daily for a period of four days. He is to furnish us with a complete stenographic report on the results of these examinations, but when calling on him a few days ago he advised us that owing to sickness and a press of business he had been unable to complete the report, but that we should have it in a few days.

This report of Dr. Cottingham will be forwarded to the United States Department of Labor to be used in conjunction with the report of the investigation made by the Department. I am sure I do not know the extent of this report or its probable findings, but if you or Dr. Miller are to make a study of this subject, I would be pleased to furnish you with a copy of the same.

Now, the Indiana stone belt, as stated above, comprises the cities of Stinesville, Ellettsville, Bloomington, and Bedford. Stinesville is about 45 miles from Indianapolis, and the four cities are situated on the Monon Route. Stinesville is reached in about two hours from Indianapolis, then Ellettsville is 5 miles farther south, while Bloomington is about 20 miles from Bedford. I should judge that an investigation could be made in the three cities in a week. We have about 200 men in Bedford, about 65 in Bloomington, 15 to 20 in Ellettsville, and but 2 or 3 at this time in Stinesville. It would be my judgment, should you decide to make an examination in conjunction with Dr. Miller, that we could make arrangements for you to get a number of men together at one time.

If there is anything further on which I could advise you, I would be only too pleased to do so. This tool has proved a most inhuman one, and we are only too pleased to interest and assist anyone who can bring it before the public. I am sure that, knowing its effects upon the members as we do, the time is not

far distant when our members will absolutely refuse to use it, which without doubt will bring on a bitter industrial struggle, as the employers seem determined to use it regardless of its effects.

I might add also that from time immemorial the stonecutter has been a victim of tuberculosis. Our death records show this disease to have taken a very large percentage of our members. The air hammer, instead of relieving this, adds to the mechanic's susceptibility of contracting tuberculosis, inasmuch as with the mallet the blows are intermittent, thus giving the dust a chance to blow away, and the cutter therefore escapes a great portion of it. With the air hammer and the constant vibration of a stroke from 3,000 to 3,400 revolutions per minute, a constant stream of fine dust is thrown in the operator's face as he bends over his work, and he has no chance of escaping even a portion of it. The inhalation of this dust invariably brings on tuberculosis.

Assuring you that we are pleased to have you take this matter up and that we will be only too pleased to assist you in any way possible, I am,

Yours very truly,

WALTER W. DRAYER,
General Secretary.

The Bureau of Labor Statistics sent into the limestone belt of Indiana two agents who conducted an investigation during the months of January and February, 1917. Statements as to the effect, if any, of work with the pneumatic hammer were obtained from 97 employees; of these, 68 reported that they had been injured and 29 that they had not. This, however, can not be taken as indicating in any way the general proportion of cutters injured, since it was impossible to interview anywhere near the total number of stonecutters in the district. Testimony was also received from 18 firms of the district as well as from two associations of which most of these firms are members. All of this evidence is here presented in full.

ATTITUDE OF THE EMPLOYEES.

EMPLOYEES INJURED BY THE AIR HAMMER.

Of the 68 limestone cutters who report being injured by the use of the air hammer, 46 work in Bedford, 16 in Bloomington, and 5 in Ellettsville, Ind., and 1 in Rockford, Ill. The general secretary of the union reports that there are approximately 200 union stonecutters at work in Bedford, 65 in Bloomington, 15 to 20 in Ellettsville, and 2 or 3 in Stinesville. All of the 29 men who state they have noticed no ill effects work in Bedford.

The ages reported by the 68 workmen range from 21 to 62 years, the average age being 34.5 years. The following tabular statement shows their distribution by age groups:

TABLE 1.—NUMBER AND PER CENT IN EACH AGE GROUP OF LIMESTONE CUTTERS INJURED BY THE USE OF THE AIR HAMMER.

Age group.	Number.	Per cent.
21 to 25 years.....	12	17.6
26 to 30 years.....	15	22.1
31 to 35 years.....	11	16.2
36 to 40 years.....	15	22.1
41 to 45 years.....	7	10.3
46 to 50 years.....	3	4.4
51 years and over.....	5	7.4
Total.....	68	100.0

As this table shows, more than three-fourths (78 per cent) of the 68 workmen are 40 years of age or less. Practically the same proportions (39.7 and 38.3 per cent, respectively) are in the age groups 21 to 30 and 31 to 40 years.

With the exception of one man, who at the time of making his statement had used the pneumatic hammer only 2 weeks, the length of experience with the machine reported ranges from 1½ to 16 years, the average being 5.8 years, as compared with 9.2 years, the average among the employees who report that they have not been affected injuriously.

In the table below are shown the number and per cent of employees injured by the hammer, classified by length of experience; for purposes of comparison the same information is given for employees who have not been harmed.

TABLE 2.—NUMBER AND PER CENT OF EMPLOYEES HARMED AND EMPLOYEES UNHARMED BY THE USE OF THE AIR HAMMER, BY LENGTH OF EXPERIENCE WITH HAMMER.

Length of experience with air hammer.	Employees harmed by air hammer.		Employees unharmed by air hammer.	
	Number.	Per cent.	Number.	Per cent.
1 and under 2½ years.....	5.	7.5	1	3.6
2½ and under 5 years.....	18	26.9	4	14.3
5 and under 7½ years.....	31	46.3	10	35.7
7½ and under 10 years.....	6	9.0	2	7.1
10 and under 12½ years.....	5	7.5	3	10.7
12½ years and over.....	2	3.0	8	28.6
Total.....	1 67	100.0	2 28	100.0

¹ Not including 1 who had used the hammer only 2 weeks.

² Not including 1 who did not report length of experience with the hammer.

Almost twice as many employees injured as those uninjured (34.4 against 17.9 per cent) have used the hammer less than five years. Four-fifths (80.7 per cent) of those injured, as compared with a little over one-half (53.6 per cent) of those uninjured, have been working with the pneumatic hammer less than seven and one-half

years. On the other hand, a very much greater percentage (39.3 as against 10.5 per cent) of workmen have employed the hammer 10 years or more among those not harmed by this device than among those affected injuriously. This may be an indication that the deleterious results, if any, appear comparatively early in the working experience, or that after a time the workman becomes inured to the constant vibration and no longer experiences any discomfort;¹ but the numbers reporting are too small to be conclusive.

The workmen complain of being injured in a number of ways. Sixty-five of the 68 employees complain of injury to their hands, 34 reporting injury to both hands, 21 to the left hand, 2 to the right, and 8 to "the hand," not specifying which one. The following table shows the injuries reported, in addition to those affecting the hand:

TABLE 3.—NUMBER OF INJURIES REPORTED AFFECTING EACH SPECIFIED PART OF BODY.

[The groups in this table are not mutually exclusive, since the same workman may have reported injuries to several parts.]

Part of body affected.	Number of injuries reported.	Part of body affected.	Number of injuries reported.
Neck.....	1	Left shoulder.....	2
Chest.....	2	Right shoulder.....	2
Right lung.....	1	Both shoulders.....	2
Heart.....	5	Left arm.....	16
Nerves.....	13	Right arm.....	2
Back.....	1	Both arms.....	5
Left side.....	4	Arm not specified.....	2
Left eye.....	1	Both legs.....	2
Both eyes.....	2		

One man says the effects are so severe that he can work at stone-cutting only two or three months at a time. One cutter says his general condition improves when he stops work for a while; three have improved since going back to the hand method; while two others declare that the fingers of the left hand are numb and turn white in cold weather whether or not they are using the hammer.

Statements made by the men would seem to indicate that, whether or not the employers consider work with the pneumatic hammer harmful, the insurance companies do. One stonecutter's rate has been doubled, another was refused insurance, except at a prohibitive rate, by three companies, and a third was refused insurance altogether.

Of those who report on the point at all, seven say that they have not consulted a physician, and only nine that they have done so. The reason given as to why there were so few of the latter was that other men who had sought the advice of a doctor had merely been

¹ The experience of 1 workman, who has been using the hammer for 11 years and who suffered extreme numbness in his hands during the first 6 years, which has gradually improved till now only the tips of the fingers are numb, would seem to bear this out.

told to stop using the hammer. This fact being generally known, the employees did not want to incur the expense of a visit to a physician.

The statements made by the employees who report that the use of the hammer has injured them are given below:

STATEMENTS OF MEN INJURED.

EMPLOYEE NO. 1, AGE 37.

I have been using the air hammer about six years.

The fingers of my left hand are numb and in cold weather they get white. My left arm pains as far up as the shoulder; the whole left side is painful—has shooting pains—and I can not sleep for hours on account of the pain. The left leg is also affected the same as the arm. Have been troubled with these pains in my arms and legs for over a year. The use of the air hammer has also affected my heart. I can not hear in my right ear. I have never been to see a doctor.

EMPLOYEE NO. 2, AGE 24.

I have used the pneumatic hammer for about six years.

The little finger and the one next to it are numb in cold weather only; the numbness extends up to the palm of the hand. I have no objection to using the air hammer, and would rather use it than the mallet and chisels. I am nervous at times, but think this comes from using coffee.

EMPLOYEE NO. 3, AGE 39.

I have used the air hammer about five years.

I have dead fingers in both hands; mostly in the left; I never have seen a physician on account of it. The hammer has had no injurious effect except on my fingers.

EMPLOYEE NO. 4, AGE 27.

I have been using the air hammer off and on for the past seven years.

The index finger of my right hand is affected in cold weather only, and I feel a pain constantly in it; gloves will not keep it warm. My left side near my heart is also affected. I judge this comes directly from using the hammer. I was sick in December, 1915, and asked the doctor if my sickness was due to working with the air hammer. He replied, "I can hardly tell, but I think it was." Within the last two or three years I have had severe headaches, one about every two weeks, lasting two and three days at a time, but occurring more frequently in the summer than in the winter. I think these are brought on by the use of this tool. It wrecks a man's nervous system. I used to play baseball, but since using the air hammer I can not throw, as I am shoulder bound.

I called on the manager of the Public Savings Insurance Co., of Indianapolis, and he suggested to me that I take out insurance on my life. He asked my age and occupation, and when he found I was a stonemason he asked if I worked with the pneumatic air hammer. I said, "Yes." He then closed the book and said, "Nothing doing."

EMPLOYEE NO. 5, AGE 38.

I have been using the air hammer about five years.

Four fingers of my left hand up to the knuckles and the first finger of my right are numb. The cause of the finger on the right hand being numb is that

I regulate the exhaust with that finger. It takes me sometimes fully five minutes or more to get the circulation back into my fingers by violent exercise.

[When this man made the above statement the left hand was like a dead hand and had a peculiar look.]

EMPLOYEE NO. 6, AGE 47.

My occupation is that of driller. I drill all the lewis holes in the stones for hoisting, using the Ingersoll air drill. I have been using this air drill about four years.

It affects me in two different ways: (1) It deadens the hand and stops the circulation of the blood, especially the fingers of my left hand. (2) It makes the muscles sore. I think that this is caused by the vibration of the drill.

I made the statement [to the employer], in the office of the mill, that I had a dead hand from the effects of the air drill. He replied that I did not have to run a drill for him.

EMPLOYEE NO. 7, AGE 37.

I have used the air hammer about four years.

My fingers get white and "go dead" in cold weather. If I am working steadily with the air hammer, my left arm goes to sleep and I can not sleep on my left side. I have never seen any physician regarding this trouble. When I am cleaning a big surface, my left hand, especially the palm, becomes very sore from the jar caused by the hammer and sharp pains shoot through it. I sleep all right except when I have a strenuous day, then I become nervous and can not sleep.

We use about 80 pounds' pressure on these hammers.

EMPLOYEE NO. 8, AGE 35.

I have been using the air hammer about four years.

Both hands are dead. I can not sleep on my left side. I have not consulted a physician, as I knew the remedy: "Stop using the hammer."

I am chairman of the Oolitic Belt Conference and have brought the subject of the ill effects of the air hammer before the Bedford Stone Club, composed of bosses. They owned up to me that there were ill effects from using the hammer, but would not go into the matter, as they considered it a national affair, and if the men did not use it they would lock the men out.

EMPLOYEE NO. 9, AGE 40.

I have been using the air hammer, all told, about six years.

It numbs both of my hands as far back as the palm. It also affects my left arm and shoulder, and at times when I have rheumatism or have taken cold, it affects my entire left side. I do not feel it on the right side except on my hand and fingers. It makes me nervous and I lose a great deal of sleep, and after a hard day's work it affects my heart. The use of this hammer affects the circulation of the blood more in the winter than in the summer months. The air used in the hammers is ice cold at all times. Dr. ——— visited me while I was at work in the yard. I handed him this air hammer, and he remarked that it would cause paralysis for anyone to use it.

EMPLOYEE NO. 10, AGE 37.

I have been using the air hammer about five years.

It deadens my fingers. The finger next my little finger gets white first and has no feeling in it at all. The hammer also affects my left arm so that I can not sleep on that side. After using the hammer constantly I am unable to

sleep at night. I have never been to see a physician to get any remedy for it, but while on other business I have spoken to doctors about it and they said it was on account of the constant jar of the hammer. We have to use the hammer or stop work. I have complained only through the committee.

EMPLOYEE NO. 11, AGE 36.

I have used the air hammer about four years.

It causes a numbness in the three fingers on the left hand, coloring them to a whitish blue yellow. When the left arm is extended it is affected with sharp, shooting pains. Use of the hammer also produces restlessness at night, resulting in loss of sleep. In the morning I spit up lumps of stone dust which were gathered during the preceding day. These have been noticed since I have used the air hammer, which covers the period mentioned above; nothing of the kind was ever observed when I worked with the chisel and mallet, a period covering about 17 years. I consulted Dr. ———, who stated he would not work at such a trade on account of the injurious effects of the air hammer.

EMPLOYEE NO. 12, AGE 41.

I have used the air hammer about three years and four months.

It causes my hands to turn white and I have no feeling in the fingers of both hands or in my shoulders, especially when I work hard. I have to sleep on my back or stomach, as I can not sleep on either my right or left side. The hammer has also affected my hearing and I notice that when I have not been working for about six weeks my hearing is improved. I have never seen a physician regarding this trouble.

EMPLOYEE NO. 13, AGE 36.

I have used the air hammer three years.

I was compelled to use the pneumatic hammer in the place of the mallet. It numbed the nerves in the arms from the finger tips up into the body and, according to physician, affected the nervous system of the whole body, stopping the circulation of blood. The fingers of my left hand are cold and stiff, mostly in cold weather. I was compelled to stop work on account of air hammer. I was examined by a physician on or about the 5th day of June, 1916, and advised to give up the use of the air hammer.

EMPLOYEE NO. 14, AGE 44.

I have been using the air hammer about eight years.

On my left hand the thumb and fingers are dead; there is no circulation except after violent exercise and rubbing. The index finger and thumb of my right hand, up to the palm, are also affected the same way. I have watched the development of the action of the air hammer on my hands. The constant vibration of the air hammer stops the flow of blood through the fingers to the tip ends, causing the veins of the fingers to become sluggish and inactive, and allowing the freezing temperature to keep the blood from circulation, so that the fingers completely die. In order to bring back circulation it is necessary to throw the arms across the shoulders for some time. The use of the air hammer also causes intense pains to shoot through the joints, arms, shoulders, both limbs, hips, and spinal column to the seat of the brain, causing a dull and heavy feeling at the base of the brain and restlessness or nervousness, and

an unnatural sleeplessness. I have not used the air hammer for the past three weeks and am now working by the old hand method. I am now getting back the natural feeling to a great extent and feel much improved in general, but I don't think that I will ever get back to normal condition, as I was before using the air hammer.

EMPLOYEE NO. 15, AGE 33.

I have been using the air hammer a little over three years.

The four fingers and thumb of my left hand are dead and I have no feeling in them, and this extends to my shoulder. I can not raise my left arm to my shoulder without taking my right hand to help. My right hand is also partly affected. In May, 1914, I could not sleep at nights. I had been steadily using the air hammer for 21 months, nearly every working-day. I consulted Dr. ——— in regard to bad heart action and he replied that there were several ways that the heart could be speeded up, as, for instance, lifting a heavy object or taking a long run. I told him that I had done neither. He then asked me at what I was employed. I told him I was a stonemason and was using the pneumatic hammer. He then told me that was very likely the cause of it. He gave me some medicine to reduce the heart action and told me to keep quiet for several days. The heart action was reduced by the quiet and the medicine, but upon my returning to work it became as bad as ever again.

One day after working eight hours I went back again to the same doctor, as my heart was bothering me the same as before. The doctor then made another examination and found the action of the heart above normal. He also found, at this time, that the nerves of my left arm were sort of fluttery or quivery and advised that I try something else for a livelihood. I did not take his advice, but returned to work. After a short while I consulted our family physician and, after an examination, he told me that the nerves were badly shattered and were being deadened, and that heart action was above normal, but that this was caused by the bad nerves. Dr. ——— explained to me that when the deadening of the nerves reached the spinal column it would result in paralysis. His advice was to quit the business, and I did quit the business at that time for five months, and I felt better and rested well at nights. I then returned to the business and worked for three months, when I became nervous again and could sleep but little. I then left the business again for a little over seven months and went to farming and have returned to the business only from two to three weeks at a time.

EMPLOYEE NO. 16, AGE 35.

I have been using pneumatic hammer about six years off and on and have used it continuously about 18 months. I have been foreman of a mill and have not used it very much in the years previous to the last 18 months.

The first two fingers and the thumb of my right hand are numb and in cold weather become entirely numb, and I am forced to rub or swing them violently in order to bring the circulation back to them. It makes no difference what kind of work I am doing these fingers and the thumb go dead in cold weather. I think the vibration caused by the air hammer is the cause of the noncirculation of the blood. The left arm from the elbow to the shoulder seems to be bruised and gives me considerable pain and causes loss of sleep at times. The fingers and thumb of my left hand are entirely numb up to about the center of the palm, and this is very painful sometimes.

Men are compelled to use the air hammers or there is no job. If you persist in using hand tools and mallet you can look for another job.

EMPLOYEE NO. 17, AGE 29.

I have been using the air hammer about seven years.

The four fingers of my left hand get numb and my arm to my shoulder aches most of the time, both winter and summer. It also affects my sleep, and I can not sleep on my left side at all. I have a pain in my chest. I think it is caused by leaning forward with both hands while using the hammer. I have to relax in order to get a full breath, but that does not stop the pain. Frequently when I take a full breath my chest bones crack. My sleep is broken at nights and I am nervous both day and night, but especially at night. I have consulted a physician in regard to a pain under my right shoulder blade. The doctor said to stop using the air hammer.

I have been unable to get life insurance. I was refused insurance, except at a prohibitive rate, by the Prudential, of Newark, N. J., the Metropolitan Life, and the New York Life on account of using the air hammer.

[The only policy the Prudential Insurance Co. will write a stonemason using the pneumatic hammer is on the 20-year endowment plan at a "hazardous" rate of \$46.98 per year, the highest rate given by the company. Stonemasons not using pneumatic tools get a medium rate; those using them are rated as "hazardous" and pay a difference of \$2.38 per thousand.]

EMPLOYEE NO. 18, AGE 43.

I have been using the air hammer about nine years.

The four fingers of my left hand, up to the knuckles, are numb and I feel a stinging in the fingers and arm. Sometimes when feeding the furnace I feel pains around my heart, and this especially when I stoop.

The Metropolitan Life Insurance Co. has increased my premium from 10 to 20 cents per week.

EMPLOYEE NO. 19, AGE 30.

I have been using the pneumatic hammer about six years.

It causes the last three fingers of my left hand to become numb, and there is no circulation in these fingers up to the palm of my hand in cold weather, but it does not seem to bother me in the summer months. It causes considerable pain. In the winter time this condition would prevent me from following any occupation where the use of my fingers would be required.

EMPLOYEE NO. 20, AGE 36.

I have been using the pneumatic hammer off and on for about six years.

It stops circulation in the fingers and causes them to become numb. On days when the work is heavy I feel it in my arms. It used to affect my sleep, but it has not done so for some time; I suppose I have become inured to it. At times it causes considerable pain, and would prevent me from doing any outside work where the use of my fingers would be required.

EMPLOYEE NO 21, AGE 29.

I have used the air hammer about five years. I am allowed to use hand tools for roughing off (pointing with mallet or hammer).

The use of the air hammer affects me in the following manner: It deadens the three fingers of my left hand—not the index finger—and the index finger of my right hand, as far back as the palm of the hand. This feeling bothers

me only in cold weather and is particularly noticeable on ordinary frosty mornings in the early fall. After a great deal of cleaning up stone or tooling with the hammer, both of my arms ache and feel as if they were asleep, and sometimes in the night I have to get up and sling my arms in order to get the circulation into them.

EMPLOYEE NO. 22, AGE 24.

I have been using the pneumatic hammer about four years.

The first two fingers of my left hand are dead—that is, have no circulation—and the hammer makes my left arm sore from the shoulder down. It affects me mostly in the winter months.

EMPLOYEE NO. 23, AGE 39.

I have been using the air hammer for about eight years, in different parts of the country.

The thumb and four fingers of my left hand, and the first three fingers of my right hand are affected, and on cold and frosty mornings I have to put them in hot water in order to restore the circulation. Work with the hammer also gives me pains in my chest and has affected my left arm between the shoulder and elbow. I do not feel natural on my left side at all. I have put my affected fingers in water so hot that my good fingers could not stand it. My arms frequently go to sleep—and this is almost a nightly occurrence, several times in a night—and I have to massage myself in order to bring the circulation back. I am very nervous at all times, and being struck suddenly, even slightly, causes me to jump. My left leg frequently goes to sleep and gets cold three times as quick as my right, and on one occasion I lost feeling in it entirely and sat in the bathtub and bathed it in hot water for three hours before the circulation returned; and it has not become entirely right yet.

I am perfectly willing to go before any unbiased physician and pass a physical examination as to the effect of the air hammer on me.

EMPLOYEE NO. 24, AGE 39.

I have been using the pneumatic hammer about three years off and on. I have used it only about nine days since last September.

The fingers and thumbs of both hands are numb, and the cold weather affects them; they are very painful. It has affected my left arm; I have a dull heavy pain in the back of my neck at the base of the brain.

EMPLOYEE NO. 25, AGE 43.

I have been using the air hammer for about five years.

The fingers of both hands are numb and in cold weather turn white. I can not write or hold anything when my fingers are in this condition; they are perfectly useless. I also have a severe pain at times in my right elbow, especially when I use the hammer continuously.

EMPLOYEE NO. 26, AGE 23.

I have been using the air hammer about two years.

The last two fingers of my right hand get cold and numb in cold weather. There is also an effect on my nerves and neck. The least racket or noise jars me and causes me to start. The stiff neck is caused by using the hammer, and is not caused by cold. My left hand is not affected at all.

EMPLOYEE NO. 27, AGE 30.

I have used the air hammer about two years.

Whenever I get in the cold my fingers and thumbs get numb and there seems to be no circulation; my left arm has shooting pains up to the shoulders. My nerves are all shattered. They frequently keep me awake at night. Since stopping work with the hammer and going back to the mallet I do not feel so bad, and am getting over the nervousness.

EMPLOYEE NO. 28, AGE 22.

I have been using the pneumatic hammer close on to two years.

It has torn up my nerves, and the nerves have affected my heart. I consulted a physician in August, 1915. He said that my nerves were all torn up and that it had affected my heart and that I would have to give up using the air hammer. The first three fingers on my left hand are numb and without feeling, and this is especially so on cold, frosty mornings. I have been cutting stone with the mallet since November 1, and my heart has not bothered me since.

EMPLOYEE NO. 29, AGE 48.

I have been using the pneumatic hammer about three and one-half years.

Four fingers of my left hand are numb, and there is no circulation in them in cold weather. Both wrists feel as if sprained. At night I can not sleep very well, and I wake up and feel that my arms are asleep.

EMPLOYEE NO 30, AGE 51.

I have been using the air hammer steadily about eight years.

The forefingers, and thumbs of both hands are numb, and there is no circulation in cold weather. Both thumbs are very sore to the touch at all times, even when holding a book. The hammer also affects my left eye, which seems to be blurred on certain days. I attribute this to the dust and air from the hammer. My back, after a hard day's work, gives me a great deal of trouble, especially after sitting down and on trying to rise. I feel this pain mostly in the small of my back.

EMPLOYEE NO. 31, AGE 30.

I have used the pneumatic hammer for the past three years on limestone and three years prior on marble in New York City.

The four fingers and thumb of my left hand, up to the palm, are numb and there is no circulation in them in the cold weather; the thumb and first finger of my right hand are affected the same way. When I lie down in bed my heart seems to flutter. My legs, when I am in bed, are always tingling, a sort of a deadening feeling running through them. I passed the insurance test for life insurance four years ago and passed the examination of the Metropolitan Life, but since then this feeling of numbness in my limbs has come, and I attribute this to the constant use of the air hammer. When holding a newspaper or book, while reading, my arms frequently go to sleep, and it is necessary to drop them in order to restore circulation.

EMPLOYEE NO. 32, AGE 35.

I have used the pneumatic hammer about seven years—five of these on hard marble at Carthage, Mo., and two years on limestone.

The thumb and four fingers of my left hand and also the thumb and fore-finger of my right hand are numb, and there is no circulation in them in cold weather. On my left hand this numbness extends back to my knuckles. My nerves are also affected; my eyes and the region above them seem to tingle and burn. If I sit with a book or newspaper and hold my hands up for any length of time—10 minutes or more—both arms go to sleep. I then have to drop my arms in order to get the circulation back again. The back of my shoulders is affected and seems numb, and I frequently have to get up at nights and rub it. I have never been to see a physician regarding this trouble.

EMPLOYEE NO. 33, AGE 32.

I have been using the pneumatic hammer about 16 years.

The four fingers of my left hand are numb in cold weather, and when in that condition have no feeling in them. Last spring my wrist began swelling and I consulted Dr. ——— in regard to it. He put splints on it and said I should stop work. I stopped work three or four days and consulted him again, when my hand was better. He was very much surprised. The doctor said, on my first visit, "I am afraid that the constant vibration of the air hammer has caused this swelling." I have been working ever since and so far have had no trouble with my wrist.

EMPLOYEE NO. 34, AGE 53.

I have been using the air hammer for six or seven years.

When my hands are idle they go to sleep and they are not sensitive to touch. I have cut stone about 35 years, but previous to the time I began to use the air hammer I never suffered any bad effects as a result of the use of mallet and chisel.

EMPLOYEE NO. 35, AGE 25.

I have been using the pneumatic hammer a little over two years and a half.

The four fingers of my left hand are numb up to and above the knuckles. My left arm and shoulder frequently go to sleep, sometimes when I am working and also at night. My hearing is affected; there is a continual hum in the ear and left side of the head, and I think this is caused by using the air hammer.

EMPLOYEE NO. 36, AGE 27.

I have been using the pneumatic hammer about seven years.

The little finger and the next two fingers of my left hand are numb. This is felt more on cold mornings than at any other time. The left arm goes to sleep at night and I can feel it jerking; sometimes it wakes me up and sometimes it does not. Sometimes when I use the rasp it cramps my hands so that I am not able to let go of the rasp.

EMPLOYEE NO. 37, AGE 32.

I have been using the air hammer about five years.

The four fingers of my left hand are numb in cold weather and turn white; this extends as far as the knuckles.

EMPLOYEE NO. 38, AGE 48.

I have been using the air hammer about 10 or 12 years past.

The four fingers and thumb of my left hand are white and numb and are very painful. When using this hammer and working without fire in the mill,

I use a yarn glove and over this glove a lined leather mitten, and it is impossible for me to keep my fingers from going numb and white. One winter I did not work at stonecutting but was driving a team of horses, and my left hand hurt me just as badly as when I was using the air hammer. It was impossible to keep the hand warm even with heavy mittens on. My left arm between the shoulder and the fingers gets numb and feels as if it were paralyzed, and sometimes it takes me nearly half an hour to bring the circulation back again. Sometimes this has happened two and three times a night. Sometimes my left wrist is so affected that the joint seems pulled in two, and I can hardly hold the tool. I think that the air used in hammers is impure to breathe, as it seems to me to be stagnated air, as it is confined so long, and I consider it unhealthy.

EMPLOYEE NO. 39, AGE 27.

I have been using the air hammer about 1½ years.

The tips of the fingers of my left hand are numb; I call them dead fingers. About five years ago this numbness extended back to the knuckles, but, as the years go by, gradually the numbness seems to go to the tip of the fingers. The only time this numbness affects me is when I use the 1-inch hammer. When using the ¾-inch hammer I seem to feel no ill effects.

EMPLOYEE NO. 40, AGE 23.

I have been using the air hammer off and on about one year and a half.

The four fingers of my left hand are numb and turn white in cold weather, and this extends back to the knuckles. The index finger of my right hand is also affected the same way. I also have an aching pain in the shoulder and the elbow joint of my left arm.

EMPLOYEE NO. 41, AGE 41.

I have been using the air hammer about 10 years.

The four fingers of my left hand are numb and turn white in cold weather, and at times this extends as far as the elbow, making the arm feel as if it were partially paralyzed, so that I can hardly grip a tool. The thumb and index finger of my right hand are affected the same as the left hand.

EMPLOYEE NO. 42, AGE 39.

I have been using the air hammer about six years.

My left arm, from the elbow to the shoulder, is very painful, and I have to rub it in order to bring the circulation back into it. I never had rheumatism, and this can not be the cause of the pain in the arm. The pain comes very frequently when I do other work or have my arm in a certain position, and when it comes on is very severe. This pain has been very frequent in the past two years.

EMPLOYEE NO. 43, AGE 30.

I have been using the air hammer about four years.

The four fingers, up to the knuckles of my left hand, are cold and white and without feeling—only in cold weather. My fingers have been this way for the past two years. It takes some time—from 30 to 45 minutes—to bring the circulation back into them.

EMPLOYEE NO. 44, AGE 52.

I have been using the air hammer about four years.

The four fingers of my left hand are numb and turn white in cold weather; on the last two fingers this condition extends to the palm of the hand; the middle finger of the right hand is affected the same way. I used the air hammers on the capitol at Providence, R. I., but on this work we used them to run draft lines, and on heavy work we used the mallet, hammer, and point, and we never even cleaned up the work with it.

EMPLOYEE NO. 45, AGE 33.

I have been using the air hammer for the past four years.

The four fingers, up to the knuckles, are numb, and in cold weather turn white, and there is no circulation in them when white and cold. I can not use the air hammer to work to any advantage when my hands get this way. So far the air hammer has not affected me in any other way.

EMPLOYEE NO. 46, AGE 54.

I have used the air hammer about eight years.

The thumb and four fingers of my left hand are numb, and this extends to the palm of my hand, and in cold weather they turn white and there is no life in my fingers. When my fingers get this way they hurt. In the past year I have felt the same kind of pains in my left arm and shoulder. This occurs when I get out of bed in the morning and continues until I begin to move them about and get the circulation started, before I can get any life into them. I can not work in very cold weather unless I get near a fire, because without the heat my hand is not in condition for working.

EMPLOYEE NO. 47, AGE 28.

I have been using the air hammer for about six or seven years.

The fingers of both hands are numb, and in cold weather get white, and there is no feeling in them.

EMPLOYEE NO. 48, AGE 23.

I have been using the air hammer about four years.

The four fingers of my left hand get numb as far up as the knuckles and in cold weather get white, and I have to smack them together in order to get any life into them. The hammer also affects the first finger of my right hand the same way.

EMPLOYEE NO. 49, AGE 21.

I have been using the air hammer off and on for the past four years.

The first three fingers of my left hand are numb and in cold weather get white. When my fingers get cold I have no feeling in them, and it requires rubbing in order to get the blood to circulating in them.

EMPLOYEE NO. 50, AGE 34.

I have been using the air hammer about 10 years.

The thumbs and the fingers of both hands are numb, and I can not keep them warm; they do not turn white. My right lung is affected and it has hurt me for the past three years; the doctor says it is tuberculosis.

EMPLOYEE NO. 51, AGE 45.

I have been using the air hammer for the past six years.

The fingers of both hands are cramped and occasionally turn white in cold weather. I am very nervous and the least excitement causes me to jump. I think this nervousness is caused by the constant vibration of the air hammer.

EMPLOYEE NO. 52, AGE 31.

I have been using the air hammer about eight years.

The fingers of both hands are numb and turn white in cold weather, and when my fingers get cold they are very painful. I have been using the 1-inch hammer, and do not feel the effects so much as from using the smaller hammer—the $\frac{3}{4}$ -inch size. Both feet, when in the same position any length of time, go to sleep; and at night I am so restless that I throw my arms about.

EMPLOYEE NO. 53, AGE 62.

I have been using the air hammer about seven years.

The four fingers and thumb of my left hand, when cold, are entirely white and numb and have no feeling in them and I can not button my shirt with them. There is also a swelling in the wrist, but it is not very painful. At night, in bed, when I turn over on my left side, my left arm goes to sleep or gets numb from the shoulder to the tips of the fingers, and I can not lie on this side for over 15 to 20 minutes. The right hand is affected only in extremely cold weather. I have cut stone for over 40 years with the mallet, and no such symptoms were ever felt.

EMPLOYEE NO. 54, AGE 45.

I have been using the air hammer about six years.

The four fingers and thumb of my left hand are numb and white, there is no circulation in them in cold weather, and this numbness extends back as far as the knuckles. When my fingers get cold and white, it takes considerable rubbing and smacking together in order to bring back the circulation to them. At night my sleep is affected, both arms seem to lose all feeling, and I frequently have to get up and rub them. The worst work with the air hammer is that of tooling. At different times I have worked at this several weeks at a time, without change, and this class of work is harder than cutting different patterns of stone.

EMPLOYEE NO. 55, AGE 26.

I have been using the air hammer about six years.

The four fingers of my left hand are numb and there is no circulation in them in cold weather. This is when they turn white. This affects my fingers up to the knuckles. The index finger of my right hand is also affected the same way. I think my eyes are affected from the use of the air hammer, as I have to wear glasses, and the glasses are stained and scarred. I consulted a doctor in 1912 and 1913, and he said my eyes were all cut up. When I go in swimming in the summer months my fingers turn white and cold.

EMPLOYEE NO. 56, AGE 40.

I have been using the pneumatic hammer steadily about five years.

The four fingers of my left hand and the thumb and forefinger of my right hand are numb and without circulation. This occurs only in cold weather;

in summer I get this numbness, but it is easily worked off in hot weather. In the elbow of my right arm there is a numbness, and a continual pain.

EMPLOYEE NO. 57, AGE 28.

I have been using the air hammer for the past three years.

The four fingers of my left hand are numb and get white as far up as the knuckles. The left arm and the elbow get cold and sting. The right hand is also affected up to the first joint. The hammer also affects my right shoulder, and in order to relieve the pain I have to raise my arms over my head.

EMPLOYEE NO. 58, AGE 31.

I have used the air hammer five years.

The only effect I feel from the use of the air hammer is that it makes the fingers of both hands white in cold weather.

EMPLOYEE NO. 59, AGE 25.

I have used the air hammer for two years.

I have partial paralysis in three fingers on the left hand and can not stand having my hand exposed in even the mildest cold weather on account of poor circulation, which makes it a useless member in severe cold though protected with heavy gloves.

EMPLOYEE NO. 60, AGE 22.

I have been using the air hammer for about five years.

The fingers of both hands as far up as the knuckles are numb and in cold weather get white. There is no feeling in them. It also affects my left arm as far up as the shoulder. This arm goes to sleep when I put it in a certain position.

EMPLOYEE NO. 61, AGE 24.

I have been using the air hammer for the past four and one-half years.

The fingers of my left hand are numb and in cold weather get white and cold. This occurs whether I use the hammer or not. The muscles of my left arm seem to be dead and are painful.

EMPLOYEE NO. 62, AGE 28.

I have used the air hammer two weeks. It has made my arm cramp and feel numb.

EMPLOYEE NO. 63, AGE 23.

I have used the air hammer five years.

Both of my hands get cold and useless, and I have pains in my right shoulder at night.

EMPLOYEE NO. 64, AGE 37.

I have been using the air hammer for nearly 10 years.

Both hands, including my thumbs, are numb and get white in cold weather. When I am in bed at night my left arm goes to sleep and there is no feeling in it.

EMPLOYEE NO. 65, AGE 27.

I have been using the air hammer constantly for the past six years.

On the left hand all the fingers are numb as far up as the knuckles and in cold weather turn white. There is no feeling in them they get so cold. My left arm aches at times.

EMPLOYEE NO. 66, AGE 28.

I have used the air hammer for six years.

I find the fingers of both hands are affected by numbness to the extreme on cold or damp mornings.

EMPLOYEE NO. 67, AGE 31.

I have used the air hammer about 16 years.

It has caused the blood to stop circulating in my hand and arm so that they often get numb, and I have to stop and rub them several minutes at a time on cold mornings in order to get circulation started again before I can resume work. Sometimes my arm gets numb to the shoulder.

EMPLOYEE NO. 68, AGE 36.

I have been using the air hammer about five years.

Four fingers of my left hand and the first three fingers of my right hand are numb as far as the knuckles; my left arm is numb and goes to sleep if held in a certain position for any length of time. My nerves are affected and I am very irritable at nights after returning from work.

EMPLOYEES NOT INJURED BY THE AIR HAMMER.

Twenty-nine stonecutters state that they have felt no ill effects from working with the air hammer. Excluding one who did not report on this point, the length of their experience with the hammer ranges from 1 to 20 years, the average being 9.2 years. Almost two-thirds (64.3 per cent) have used the hammer from 4 to 10 years and nearly 39 per cent 10 years or more.

Twenty did not testify individually but signed a general statement that the hammer had not been harmful to them and they favored its continued use. Of the nine who made separate statements one says he had trouble with his right shoulder and with his heart when working by the hand method, but since he has been using the pneumatic hammer this trouble has disappeared; another states that he can work without gloves in the coldest weather; and a third declares he would leave the industry if compelled to go back to the old way because of the greater demands made on the strength by the hand tools. Still another reports that he has never seen a stonecutter suffering from any injury except the "common ills that naturally follow the occupation of cutting stone"; he does not state what these "common ills" are.

STATEMENTS OF MEN NOT INJURED.

EMPLOYEE NO. I.

I hereby certify that I have used an air hammer for 17 years and have never felt any injurious effects, and prefer to use it instead of the old method of hand tools.

EMPLOYEE NO. II, AGE 42.

I have been using the air hammer about six or seven years.

The fingers of my left hand turn white in cold weather, but my fingers do not get numb. Before using the air hammer and while using the mallet and hand hammer I used to have such pains in my right shoulder that I could hardly put my coat on or take it off. The work is not half as hard with the air hammer as it was with the mallet. My heart used to bother me when I used the hand tools, but since using the air hammer I do not feel that bother.

EMPLOYEE NO. III, AGE 35.

I have been using the air hammer about 13 or 14 years.

I have never had any ill effects from using the hammer. I have done carving and during the past 11 years have cut stone, using the air hammer nearly all the time.

EMPLOYEE NO. IV.

I have been in the mills as a stonemason for the past 14 years—eight years in the monumental business and six years at my present place. During all this time, I have been using pneumatic tools in my work. The $\frac{1}{4}$ -inch tool is used most, but occasionally I use the 1-inch hammer.

During my 14 years of using the pneumatic tools, I have not found the air hammers to be injurious. They create a finer dust than the mallet and chisel but I have never found this dust to injure me in any way. These hammers have never affected me with paralysis or anything on account of their use. In fact, I have not found their use to be detrimental in any way. If these were to be discarded, I fully believe that I would quit the business. I have used these hammers during practically all the time I have been in the business, and I do not feel that I could stand wielding the mallet all day now. I can do much more work and more satisfactory work with the air hammers, so that it would be a hindrance rather than a benefit to me to lay them aside. Personally, I am in favor of the air hammer for cutting limestone.

EMPLOYEE NO. V.

I have used air hammers for six years and can positively say they have never hurt me nor my health.

EMPLOYEE NO. VI.

I have continuously used pneumatic tools for carving for a period of 20 years, and have never experienced, to my knowledge, any ill effects from same. Nor have I, during that time, seen anyone suffering from any other than the common causes or ills that naturally follow the occupation of cutting stone.

EMPLOYEE NO. VII.

I have been using the air hammer for about 17 years and have never suffered any ill effects as a result of its use, nor have I ever known of anyone who suffered any permanent injury from the use of the air hammer.

EMPLOYEE NO. VIII, AGE 44.

I have been using the air hammer about 17 years, nearly continuously.

The hammer has never affected me in any way. I can work with it in the coldest weather without gloves. I use the $\frac{3}{4}$ -inch, 1-inch, and the pistol-grip 1-inch Boyer. I have used the pistol-grip hammer for about six years.

EMPLOYEE NO. IX.

[Agent found this man at home sick. He said that he had rheumatism in the right shoulder and arm, and that this was brought on by an attack of grippe and was not caused by the use of the air hammer. His hands do not get numb nor do they get white in cold weather. He has been out of the city on different jobs of erection of stonework and does not use the air hammer constantly.]

NO. X.

[Signed by 20 employees.]

We whose signatures are attached hereto are practical and working stonecutters and are users of the air hammers, having employed them in our work covering the periods named, following our signatures, and have not found them injurious to our health or otherwise, and we favor their continued use for cutting and carving stone.

[The above statement was followed by the signatures of the 20 men and the number of years each had used the pneumatic hammer. The years of experience range from 1 to 20, the average being $7\frac{1}{2}$ years.]

ATTITUDE OF THE EMPLOYERS.

Sixteen firms report an experience in the stone industry of from 12 to 45 years, and with the pneumatic hammer of from 5 to 25 years.

One firm states that there is no discrimination in the district against a workman because of his lack of experience with the hammer; one that the use of the hammer is not compulsory. Seven others make the point that the hammer is only a finishing tool and a good deal of the work can be done by hand, thus placing the blame on the stonecutter if continuous use of the hammer injures him. One employer thinks that the "foreman in all mills should see that the mash hammer and mallet are not discarded and insist on their use where expedient."

Three employers assert that, so far as their knowledge and experience go, there have been no instances of workmen being "permanently" injured or disabled; two that there have been no "serious" effects; five that none have been "injured" or disabled; three that they know of no case of paralysis, tuberculosis, or insanity (as the case may be); and one that he knows of no "death" from tuberculosis. Two confine themselves to the statement that there have been "no complaints," and the superintendent of one of these adds that he does not know of a "single case of paralysis or tuberculosis." One

employer makes the general statement that "this invention is a decided success if not abused by the workmen themselves." Six of these firms qualify their statements as to the harmlessness of the air hammer by making it conditional on the proper use of the tool.

Eight of the 17 companies mentioned above claim that the workmen themselves prefer the air hammer to the hand tools, as shown by the fact that they refuse to work by hand, and complain or go home when the compressor breaks down.

Only 5 of these 17 employers specifically admit that there are detrimental results of work with the pneumatic machine, and these minimize the evils. One of these says he understands that the three small fingers of the left hand have "poor blood circulation and sometimes become null;" one that the fingers do get cold but not more so than by the old method; one that the fingers get chilled on a cold day but otherwise there is no harm; one that the "abuse" of the hammer causes the hand to become "cold and lifeless" in cold weather; and the last that there is "some slight disturbance of the circulation of the hand that holds the tool."

Employers attribute the men's complaint to various motives. One says the cause is the "natural dislike of the workman to try a new method;" one that the cutters oppose the hammer because it is a machine; two that the men fear the hammer will displace labor or think its abolition will mean "work for more men"; one that the movement is in line with the opposition of the printers to the type-setting machine; one that the complaint is intended merely as a "help to higher wages;" and one that the men are trying to "block the wheels of progress."

Four employers plead the necessity of the hammer on the ground of better work produced with it; and eight others because more work can be done when it is used, or for the reason that it cuts down the cost of production and enables them to compete with makers of artificial stone. Two of these firms claim that the abolition of the machine would be disastrous to the business; while two say it would cause serious injury to it.

In order that certain firms should not be counted twice, statements No. 1 and No. 2, which follow, have been disregarded in the preceding discussion. Both are from employers' associations. Statement No. 1 discusses only the question of wage rates. Statement No. 2 is from an organization of 19 firms, of whom all but 3 also made individual statements, and covers most of the points dwelt upon by the various employers. In it the stand is taken that the function of the hammer is well defined, and if in practice the cutter misuses it, that is no fault of the employer; that numbing resulting from "choking" the exhaust with the thumb can not be held chargeable to the hammer; that conditions in the trade are much better than in

structural-iron work and yet no complaint has been heard from these employees; and that the use of the air hammer is part of the labor contract and is necessary in the business to keep down the cost of production.

The statements received from the employers are given herewith:

STATEMENTS OF EMPLOYERS.

NO. 1.

[An employers' association.]

I duly received your favor of the 13th requesting additional information in connection with the air-hammer investigation. Would have replied sooner but for the fact that I wanted to develop fairly exact figures for this proposition.

I am unable to take this matter back as far as 1880, but believe it can safely be assumed that the scale of wages antedating 1900 was probably much on the same level. The only change there might be would be in the number of hours. Working hours were a pretty elastic proposition previous to the last decade, as is a well-known fact.

I have before me a newspaper clipping of one of the Bedford papers which shows that in March, 1900, the following scale of wages applied:

Planer men, 20 to 25 cents per hour; head sawyers, 20 cents per hour.

In 1903 these classifications are quoted as follows:

Planer men, 28½ cents per hour; head sawyers, 22½ cents per hour.

I have before me the agreement between the Bedford Stone Club and the Stone Planer Men's Union No. 12866, of Bedford and vicinity. As explained to you in person, this union is not affiliated with the American Federation of Labor. Agreement in question is dated April 6, 1915, and runs for a term of five years, except as to wages, which are subject to annual adjustment.

The agreement establishes 59 hours as a week's work, and overtime is allowed up to 12 hours per day in emergencies with the provision that emergencies shall not exceed 6 days in 60 days.

The wages are established as follows:

Section 14 of agreement. It is agreed that the wages for planer men, lathe men, header men, and shaper men will be 35 cents per hour while working on planers, lathes, headers, and shapers, and when operating circular planers to be paid 40 cents per hour.

Since that time the scale has been advanced from 35 cents to 37½ cents and is due to be advanced to 40 cents on September 1, 1917, to stand at the last-named figure until March 31, 1919.

Workmen on diamond saws were paid, until about a year ago, 27 cents per hour and are now on a basis of 30 cents per hour, likewise being on a basis of 59 hours per week.

You understand, of course, that the operation of a circular diamond saw does not involve nearly the expertness required of a planer man or lathe man.

You are correct in your assumption that carvers are paid \$1 per day more than the stonecutters.

NO. 2.

[Written in behalf of 19 member firms.]

Following our conversation yesterday in regard to the use of pneumatic tools in cut-stone establishments, I wish to submit the following:

The employment of so-called air hammers is simply a matter of evolution in the stone-working trade exactly as is the use of planers, circular saws, lathes, and any of the other numerous devices without which the business could not exist to-day.

Just as all these other machines named serve their particular purpose and were intended to be used in a certain manner, just so the function of the air hammer is well defined in theory. If in practice it is misused, that is a proposition over which investigation will show the employer has no control. Many employees have acquired the habit of using the air hammer indiscriminately and without regard for the manner in which it is supposed to be handled.

The air hammer was never intended for so-called "roughing out" or "coarse work"; it was intended for the lighter and finishing operations. It is to the employer's advantage to have the correct hand tools used for roughing out, etc., rather than air, because compressed air is one of the most expensive agencies in any shop.

Many stonecutters, however, use the air hammer contrary to the principles which should properly govern. Some of them seem to think that it is easier and requires less exertion to use the air tool than to use the hand tool. Likewise fewer and fewer stonecutters carry a properly equipped kit. The employer furnishes the air-tool equipment, hence it saves the stonecutter money to operate with an incomplete kit of his own, not containing the proper hand tools. He simply depends on the employer for the necessary equipment by way of air tools.

An incidental practice of many stonecutters in the use of the air hammer is choking the exhaust with their thumb for the purpose of lightening the stroke. This choking of exhaust sends the air forward and discharges it alongside the bit, directly onto the fingers of the operative. Numbing resulting from such misuse of the tool is of course entirely chargeable to the man and not to the air hammer.

Would also state here that the claim that the dust created by these machines is injurious adds nothing so far as the general working conditions in the trade are concerned. Stone workers have at all times, centuries before machines were in use, been more susceptible to pulmonary diseases than workers in most other vocations. This condition, however, does not exist so much in the limestone industry as it does in the sandstone and granite trades. Limestone, particularly oolitic limestone, has not the physical characteristics which make other stone dusts so deleterious. It is more than likely that the air hammer would tend to better these particular conditions, inasmuch as when the air hammer is properly used the exhaust blows the dust away from the worker. It thus has no opportunity to hang suspended about him in the shop's atmosphere.

We are convinced that upon an unbiased investigation of cases of paralysis and the like which it is charged are directly attributable to the use of the air hammer, they will be found to have their source in an entirely different cause. If any person endeavoring to use an air hammer and apparently in good health generally notices evil effects from the operation, it can only be said that he is a misfit in the trade. We would refer in this connection to occupational diseases in other branches of industry. The wool picker is subject to anthrax, the lead-smelter employee to lead poisoning, the painter and glass blower to their peculiar hazards. But because of these conditions, must the use of wool be discontinued, the refining of lead stopped, and every other vocation eliminated in the execution of which exist inherent risks for a few isolated and peculiarly susceptible workers?

If the use of the air hammer is made impossible in the stone industry and resort had to antiquated methods depending upon hand tools entirely, the cost of stone will rise to such an extent as to make it alarmingly difficult, if not entirely impossible, to compete with the numerous substitutes which already have encroached so disastrously on the natural product's rightful markets. In carving, air tools are as necessary as the skill of the carver himself. Take away the air tool and the carving branch of the craft will vanish.

The stone industry probably employs but a small fraction of all the air hammers and similar devices in use in the United States to-day. It is a peculiar but significant fact that no complaint has been known to have been filed by structural-iron workers and the labor element in shipyards. Yet there are far more air hammers employed in these two branches of industry than in ours. At the same time the use of air hammers by steel workers and shipyard employees is subject to many more unfavorable conditions in general than prevail in the average cut-stone establishment to-day. Reference need be had here only to the fact that the majority of cut-stone establishments are inclosed and surroundings made as comfortable as possible for the employee. Compare with such working conditions circumstances surrounding the structural-iron workers engaged in building construction and in shipyards.

It has been said that the structural-iron worker does not use the air tool as continuously as does the stonecutter. Comparison will show, however, that the structural-iron worker does actually use his tool practically without interruption, whereas the stonecutter, if he does so, is acting contrary to what is expected of him and is following only the dictates of his own convenience.

We contend that it is eminently unfair that the Journeymen Stone Cutters' Association of the United States should attack the use of the air hammer in our division of the industry, while never a murmur of complaint has been heard from the marble and granite working part of the trade, yet we dare say that marble and granite shops employ a far greater number of air hammers than we do.

The history of the rise in wages in the Indiana limestone district is approximately as follows:

1898.....	35 cents per hour.
1908.....	50 cents per hour.
1909.....	50 cents; 56 $\frac{1}{4}$ cents; 62 $\frac{1}{2}$ cents per hour (sliding scale).
1913.....	56 $\frac{1}{4}$ cents per hour.
1914.....	60 cents per hour.
1915.....	62 $\frac{1}{2}$ cents per hour.
1917.....	67 $\frac{1}{2}$ cents per hour.

The foregoing schedule is not exact, particularly as to time, but is sufficiently so to indicate that the constant rise in the amount of remuneration paid the stonecutter in this district is such as will serve to prove that the industry has given full recognition to the workmen, while it was developing its mechanical equipment on modern lines. Another factor to be considered is that the regularity of employment has become such as to do away nearly altogether with the losses of time which formerly were so prevalent. This regulation of employment is attributable to the creation of inclosed shops and markets which are sufficiently diversified to make possible operations the year round. In other words, only a short time ago a stonecutter earned 25 per cent less than to-day and worked perhaps nine months in the year, where at the present time he rarely loses more than one month in any twelve, if that much.

The operators have a working agreement with the Journeymen Stone Cutters' Association of North America and Canada which has some time yet to run

and provides, among other things, that the use of machinery shall not be interfered with. This attack on the air hammer is an infraction of a contract made by the employers in good faith. It is an attack actuated solely by the desire to retard the economical development of the stone industry for the single purpose of making room for more workmen by elimination of a successful and necessary mechanical device. The elimination of the air hammer will, through increased operating cost, curtail the use of stone to such an extent that far more workmen will lose their employment from that cause than will find a new berth because handwork supplants efficient mechanical operation with air hammers.

The primary purpose of the attack being made on the air hammer by the Journeymen Stone Cutters' Association of North America is to retard and prevent, if possible, the logical development of the industry. This can not be accomplished any more than similar attempts in the United States and abroad have succeeded in other branches of commerce where the employment of labor-saving machines and devices was a vital factor.

EMPLOYER NO. 3.

In reply to yours of the 15th, the air hammer has been in use in our plant for about six years. While it has never been compulsory for the men to use this tool, we consider it very efficient on some classes of work; on other classes we do not believe the tool pays, as the rough work can best be done with the hand tools.

The rough work is reported to have the injurious effect on the men, if there is any, and the men being the sole judges as to what class of work the air tool is best adapted, have abused the use, and their trying to use it continuously on all classes of work seems to have caused all the trouble about the air tool.

When first installed in our plant we only had air enough for two tools, and the men continually urged us to get more tools and a larger compressor, and they complain when the compressor is out of order.

We believe the main idea in doing away with the air hammers is to make work for more men, reducing the efficiency of the men employed and greatly increasing the cost of cutting some classes of work, which would be ruinous to our business, as our product comes in competition with other building materials, such as art stone and terra cotta.

A few years ago the stonecutters legislated against the planers, and in some cities succeeded in doing away with them, but finally found they had come to stay, as the air tools have.

We know of no serious effect on the health of the men from the use of the air hammers, and if put out of use some men now cutting stone would have to leave the trade as they can not cut stone with a mallet. As the writer is a stonecutter, I speak from personal experience.

EMPLOYER NO. 4.

Complying with your request of the 7th instant regarding this company's opinion, also the personal opinion of the writer, regarding the use of the pneumatic, or air, hammer as applied to the cutting of stone; and further dealing with the subject as to whether or not this hammer is injurious to the general health of the operator, in that it ultimately causes paralysis, tuberculosis, and a general breakdown of the nervous system.

Answering the above, can state there is no such condition existing in this industry as applied to this field; neither do we know of a single instance where physical disability has been traced to the use of this hammer. Men here use it almost universally by choice, and our judgment would be, if one is elected to cut stone, the pneumatic hammer not only increases the operator's efficiency, but serves to make it easier for him to maintain his efficiency rather than add additional hardship.

The above would incorporate our opinion based upon many years in this field, and includes the life of the air hammer in cutting stone.

In conclusion can state should your department see fit to call upon us further, we will be pleased to serve you in any way possible.

EMPLOYER NO. 5.

We have used the air hammers in the cut-stone business for the last five years, and, to our knowledge, there has been no one permanently injured or disabled on account of using them. We do know that the three small fingers of the hand in which the stonecutter holds the tool (but not the hammer) have poor blood circulation and sometimes become null. These air hammers are a great necessity in the Indiana limestone business, as by using them you can procure a better finish of stone.

EMPLOYER NO. 6.

We have been using air tools in the manufacture of exterior building stone for about eight years, during which time we have used from 2 to 20 air hammers, and in no case do we know of any of our employees who have been permanently injured from the use of the same.

We believe that the stonecutters do about 20 per cent more work with the air hammer than by the old methods.

The conditions under which our employees are now working are much better than they were 10 years ago, the shops in the Bedford and Bloomington districts being all practically inclosed and heated.

EMPLOYER NO. 7.

We have before us the statement of Mr. Griggs, president of the stonecutters' union, relative to the injurious effects of stone dust and the air hammer. His statement is that tubercular affections result from the inhalation of stone dust, and that paralysis and insanity follow quite generally the use of the air hammer.

We have been in the stone business here some 25 years, the writer the same length of time. Never have we known of a case of paralysis or insanity among stonecutters in this district. Nor do we know of a case of tuberculosis. In fact it has always seemed to us that the stonecutters were a particularly healthy and prosperous class of workmen. We understand there is a more or less national movement¹ looking to the settlement of the health issue involved in the use of the air hammer.

EMPLOYER NO. 8.

Considerable agitation has been started in this district recently by stonecutters to abolish the air hammer, as used in connection with our stonecutting operations, on the ground that it is harmful to the operator. I have cut stone myself for 12 years in the old way and have been a daily observer of the new

¹ See Appendix B of this report.

way (air hammer), and I deny that any injury is caused by the use of the air hammer.

I have interviewed any number of cutters using them and have yet to find one who said it hurt him more than the old method.

It is claimed that they get consumption from the dust. Well, I have eaten considerable myself without the aid of the air hammer.

Few men get consumption from working limestone, with or without the air hammer. By far the larger number that suffer from this disease are sandstone workers, because there is grit in sandstone that is harmful. So why blame the air hammer when it is not employed in cutting sandstone? The claim is put forth that the little finger and the tips of the others become cold from holding the hammer. This is true; but, believe me, your fingers get cold, too, by the old method, as I can testify by 12 years' experience.

Just to illustrate what our cutters think of the air hammer, I will call your attention to the fact that every time our compressor breaks down the cutters, rather than work with their old hand tools for an hour or two, will quit and go home until repairs are effected.

To me this is evidence that agitation is all by men outside of this district who never worked with an air hammer and who are always against a tool because it is a machine, if for no other reason; and this, too, notwithstanding that the use of these tools enables us to cheapen nature's best building material to a point where it is possible to compete with substitutes that are manufactured nowadays.

In summing up, I think that there is more or less abuse of this little tool by the cutters in trying to remove too much rough with it, instead of using the hand tools to do so and just using the air tool to clean up with. I believe it will be necessary for our two associations to get together and formulate working rules that will eliminate some of this trouble, as it would now be a serious loss to us to abolish this tool.

EMPLOYER NO. 9.

I am an employer of stonecutters and am a practical stonecutter myself. I have been a resident of Bedford off and on for 34 years, and have been an employer of stonecutters for 20 years and have seen the development of the air hammer in the stone industry of Bedford and vicinity. The company of which I am manager has used the air hammer for about eight years.

Having learned my trade using mallet and hammer, I was somewhat prejudiced against the air hammer not because of any injury it would do the user—as that was something I had not heard of or heard mentioned until late last fall—but the natural dislike of a man having learned his trade in a certain way to adopting a new method.

I am at present heartily in favor of the air hammer, as I find the stonecutters are more efficient by its use; and the more skillful the man is in the use of the hammer, the more he is in favor of continuing its use in cutting and carving stone. The objection to its use is from men who have always used the mallet and chisel and do not take kindly to a new method.

I do not know of any discrimination being made against anyone in this district because of their lack of experience in the use of the air hammer, but I do know of at least two men here who cut stone with me right here in 1883 and are still here cutting stone.

I do not know of anyone, and have never heard of anyone, being injured by the use of the air hammer, but I have heard plenty of complaints from users of the air hammer against any effort to deprive them of its use in cutting and carving stone.

EMPLOYER NO. 10.

We have read with care the address of Mr. Griggs, president of the Journeymen Stone Cutters' Association of North America, at the annual business meeting of the American Association for Labor Legislation, held in Columbus, Ohio, December 29, 1916.

We do not agree with Mr. Griggs in his statement that the members of his association are more or less subject to tuberculosis. The writer has been in charge of stone mills in which stonecutters have been employed, for the past 25 years, and I can not recall one single case where a cutter's death was caused by this disease. I particularly refer to cutters who have been at work on Indiana limestone. I have heard it said of cutters in the sandstone district.

With reference to the use of the air hammer, I was personally acquainted with and employed for a time, R——— D———, the cutter who Mr. Griggs states died from the results of having used the air hammer in cutting stone. Mr. D———, I recall it, used the air hammer for about 3 or 4 years, and yet we have men in our employ at this present time who have been using the air hammer for the past 20 years, and in conversation with them they have advised me that they much prefer the air hammer to the mallet and chisel, stating that by using the air hammer their work is very much lightened. It is true that a cutter can do considerably more work in some classes with the air hammer than with the mallet and chisel, but I find that the cutter becomes so attached to the air hammer that he uses it on work on which the mallet and chisel are best adapted, and I have personally objected to cutters employed in our plants using the air hammer on heavy work. It is our desire that the stonecutter use this air hammer only in cutting light work or finishing and cleaning up, but I find that the cutter prefers to be left alone and allowed to use his own judgment in the use of the air hammer, and, as stated above, he will invariably use it on work for which it is not intended and thereby disregard our instructions.

I also wish to call your attention to a pamphlet which I attach herewith and which you will please note has been issued by the manufacturers of an imitation stone. I stated above that more work can be done with the air hammer than with the mallet and chisel, and it is quite necessary that it should be so when you take into consideration the fact that we are competing with this imitation stone. It is necessary that we adopt more efficient ways in the cutting of our material so as to compete with the manufacturers of imitation stone. In conclusion I repeat that it is absurd for Mr. Griggs to advise the American Association for Labor Legislation that such damaging results are being obtained by the use of the air hammer in this district.

EMPLOYER NO. 11.

With reference to the use of the air hammer, will say that the first air hammer that was used in cutting stone in Bedford was introduced in my mill in 1896. They have been in constant use for 21 years, and I know of no disability caused by their use to anyone in my employ.

We naturally wonder why the use of this tool is complained of in connection with stonecutting as injurious, when there has been no complaint from steel workers and other industries that use this tool.

We think this complaint has been started only as a help to higher wages and is not a just complaint, nor do we consider this tool injurious to the health of the users.

EMPLOYER NO. 12.

At your request, as to whether the air hammer as used by stonecutters is injurious to their health or not, we wish to make the following statements in reference to the use of compressed air as applied to stonecutting, which is our honest and candid opinion based on 15 years' experience in almost daily contact with the use of stonecutters' air tools.

We have heard that stonecutters have said that the air tool hurts them. We have also asked a great many if the air tool affected their health, and have been advised that, outside of chilling their fingers on a cold day, it did them no harm. They have also expressed themselves in private (not for publication) that they thought the use of the air tool now to be absolutely necessary. It enabled them to turn out more work with less physical exertion than the mallet and hammer. We have never known of a case where a stonecutter was in any way physically injured by the use of the air tool.

The air hammer, as used in our plants, is a finishing tool, but the cutters will persist, of their own accord, in using it for heavy work, which can not be done any quicker with the air hammer than with a hammer and point.

The worst complaint we have had about the air hammer is the water that gets in the pipes and comes through the tool, keeping it cold and wet in cold weather. We are anxious and willing to find out and adopt any practical method to overcome this. We are now, as an experiment, contemplating running the air-pipe main line through a heated coil, to see if the heat will not dry up the moisture in the pipe and keep the air warm until it reaches the tool.

In conclusion, the air hammer, in our opinion, while it is a labor saver on elaborate work, is also a promoter of the use of stone. Its use is a progressive step in the wider use of stone for construction and ornamental purposes.

EMPLOYER NO. 13.

Referring to your request for our opinion as to the use of air tools producing tuberculosis, insanity, and paralysis, beg to say we have used air tools for over 25 years in our plants and have yet to learn of a single case of any of the above maladies being rightfully chargeable to the use of the air tool. We have cutters who have been in our employ practically the entire period and are and have been using this tool with no ill effects whatever.

It is one of the best, if not the best, labor-saving devices in our business and would work an irreparable injury to the cut-stone business if abandoned or restricted in its proper and legitimate use. We feel confident that a careful medical investigation of history of those cases cited by the stonecutters' union regarding the above-named diseases will in each instance result in the air tool being found "not guilty" of the charge laid against it. The writer's personal knowledge and observation have convinced me of this irrefutable fact, and we challenge the opponent of the use of the air tool to successfully disprove this statement.

The use of this air tool permits stone to be used where the expense of doing the work by hand, which can be done by air tools, would prevent the use of stone entirely; and were its use prohibited to-day there would be less stonecutters employed than at present, as soon as the present contracts for cut stone could be finished.

The objection to the air tool is founded on a short-sighted policy of trying to block the wheels of progress. These same men, had they been canal drivers or stage drivers in the days of the canal and stagecoach, would have opposed the railroads as they oppose the air tool, and from the same mistakable and selfish viewpoint. We consider the air tool a blessing—not a curse.

EMPLOYER NO. 14.

Permit me to say that I have been in touch with this tool since its introduction, in a general way having assisted Mr. William Pascoe to install complete plant for the Norcross Bros. Co., at Providence, R. I., 18 years ago. This plant consisted of 36 hand machines, designated at that time as class A, B, and C tools, their piston capacity being $\frac{1}{2}$ inch, $\frac{3}{4}$ inch, and 1 inch. In addition to this, we also installed four hoists of 5 tons each. I merely state these facts for the satisfaction of any inquirer as to my ability to speak and talk of my experiences in handling these machines. This plant referred to was installed by the Wolstencroft Co., of Philadelphia, Pa., I, myself, being employed by the Norcross Co.

The use of hand tools up to 1 inch is positively harmless; as out of the thousands of men I know who have used this tool I have yet to see the man who has been permanently injured in any way, who has made a study of the proper method of handling the machine and, with an unbiased mind, gone about to learn its proper use. I have had criticisms from a few who had grown so much accustomed to the old method that they had tubercular trouble the day after they began the use of the machine. They could not master it because they did not mean to master it.

When operating a pneumatic hammer the operator should always keep the exhaust from the valve pointed straight up into the atmosphere, in order that the air from same will not play on the body of the operator.

As an explanation: On practically all hose connections there is a shut-off valve which controls the operation of machine. When the operator completes large member, or rather wishes to reduce the strength or weight of blow delivered by machine, he muffles the exhaust of machine by turning it around far enough so that the exhaust is covered, either by placing the thumb on hole or by allowing it to lay in hand between thumb and forefinger. This compels back-firing. In other words, the exhaust is compelled to find exit at lower end of machine, through small oil slot cut in inner chamber. This air blowing on left hand which operates the chisel is the one affected. The hand holding the machine is never affected. This abuse causes the fingers of the left hand, in cold weather, to get cold and lifeless, remaining until proper circulation of entire body has been attained. Otherwise the anatomy is unharmed.

If the use of this machine was harmful it would affect the hand holding the machine, but this is not the case. This machine, when properly and scientifically operated, is a help to the stonemason and, like everything else in space, is harmful when abused. It is the abuse of the machine and not the use. This condition, I believe, is getting better, as the younger man is more progressive and learns to use it properly. The foreman in all mills should see that the mash hammer and mallet are not discarded and insist on their use where expedient. The pneumatic hammer is then a wonderful help to a willing worker.

EMPLOYER NO. 15.

In reply to your valued and interesting favor of February 1, beg to say that we must acknowledge that we have never conducted an investigation as to the effect of the use of the air hammer stonecutting tool on the health of the workman or workmen using same. However, we can positively state that at no time have any of our workmen complained to us in person or in writing that said tool was injuring their health in any way. We never heard of the injurious effects of the use of the tool except from Mr. Griggs. We earnestly believe that the statements made by the said Mr. Griggs should not be taken at their face value until duly verified by your department.

Ap[ro]pos of this subject, we respectfully direct your attention to an article published this year in the January Stone, on page 23. This publication is devoted exclusively to the interests of the stone industry, and is edited by Mr. Frank A. Lent, 258 Broadway, New York. We are taking the liberty of mailing to you our January copy of this publication.

If at any future date we can be of service to you or your department please command us.

[The following is the agent's statement of the personal opinion of the superintendent of the above firm:]

The superintendent of the above company says he does not know of a single case of paralysis or tuberculosis due to working in a stone mill. He attributes the protest against the use of the air hammer to the fear of the displacement of labor, which fear is unfounded because the introduction of the air hammer has made more work, given employment to more men, simply because it has cheapened the product, thus enabling them—the stone manufacturers—to compete with the producers of imitations and substitutes.

He further states that the air hammer is intended only for carving, cleaning up, etc., and not for pointing or roughing out; but, regardless of advice to the men in this respect, they use the air hammer for this heavy work. The bad effect, if any, is due to this misuse of the hammer.

The company will, another year, install an arrangement for heating the air in the hammer.

EMPLOYER NO. 16.

Have been in the stonecutting business for about 25 years, and the air hammer has been operated about 8 years, during which time I have never had brought to my attention any serious troubles caused by the use of the air hammer.

It has been observed that there is some slight disturbance of the circulation of the hand that holds the tool, which is due to the abuse of the use of the tool. The tool could be laid aside and the hand method used and do just as much work on certain kinds of work; but, owing to the fact that they do not like to exert themselves, they—the stonecutters—continue to use the air tool.

The air hammer will do at least, on an average, about 25 per cent more than the hand method, and at the same time better work is done by using the air hammer than by the hand method. There is less dust with the air hammer than there is by the hand method, because the exhaust on the air hammer keeps the dust moving constantly.

EMPLOYER NO. 17.

In reply to the statements of Mr. Griggs, of the stonecutters' union, relative to the injurious effects of the stone dust on the workmen in bringing on tubercular troubles and the air hammer in bringing on paralysis and insanity, would say I have been engaged in the producing and working of Indiana limestone for the past 45 years, and, so far as observation has gone on the tubercular question, there is no basis for such a statement from working Indiana limestone. I know nothing of the effect from working others. At this time I can not recall a single case of tuberculosis from any workman of stone in my 45 years' experience.

My air-hammer experience is not for so long a period, but I have been conversant with it for the past 10 years; and, so far as I know, there has not

been a case of paralysis or insanity resulting from its use; and from my investigations I feel perfectly safe in saying there is no higher percentage of paralysis or insanity among the men who use the air hammers than there is among men who have never used them. Personally, I do not know of a single case, and the only case I have heard of is the one mentioned by you, which I have not investigated as yet.

I was a member of a committee from the Bedford Stone Club to meet with a committee of stonecutters from what is known as the Bedford Stone Belt Conference,¹ consisting of the local organization of Bedford, Bloemington, Ellettsville, and Stinesville, to adjust working arrangements and wages from January 12, 1917, to January 12, 1918, and this air-hammer question was up for our consideration and was settled by agreement that we take the question up with our international executive committees, asking that they investigate thoroughly whether or not the use of the air hammer is injurious to the health of the workman, and if found to be to either regulate its abuses to the point where it would not be injurious or eliminate its use entirely. The club committee took the position that it was not injurious so far as they could learn and were more than willing that it be given a thorough investigation by the heads of both international organizations and settled by them as an international question instead of by us as a local question. This was accepted by the committee of workmen, and the question has been so referred, and I have no doubt that within the next few months an exhaustive inquiry will be made and some conclusion arrived at for the future use or elimination of this tool.

EMPLOYER NO. 18.

Regarding air tool or pneumatic hammer used in the cutting of stone, this invention is a decided success if not abused by the stonecutters themselves. The majority of workmen refuse to work with mallet and chisel and use the hammer continuously every day. It is quite possible that this excessive use is injurious to some workmen. The bulk of our work is such that a man can use and work with a mallet and chisel a good part of the time, but the use of this tool is less exerting, and so the men try to use only this tool and attempt to do all their work with it. The reform must come from within the union, as attempts to regulate the use by employer have failed. My suggestion would be that if the union rules demanded that all "rough" to be taken to a surface of tool chiseling be required to be done by mallet and chisel and hammer and point, the cleaning only to be done by machine, this would eliminate all abuses and be an advantage to the men as well as to the employer.

EMPLOYER NO. 19.

[Agent's statement.]

The representative of this firm stated that he had been in the stone-mill business for about 25 years, but as he had installed in his plant only two 3-inch air hammers, they having been put in only recently, he did not feel competent to pass on the effect of the hammer on the workman. He says, though, that if the pneumatic hammer were withdrawn from the large cut-stone mills in this district the mill operators would have to close out, as they could not compete with the producer of imitation stone and substitutes.

¹ See Appendix B of this report.

EMPLOYER NO. 20.

As an employer of stonecutters since 1888, during all of this time located here in Bedford, Ind., we believe that we are qualified from our past experience to give the following conclusions in regard to the use of the pneumatic tool in our locality.

During all of this time we, of course, have not had the pneumatic tool, but for the past 12 or 15 years we have constantly used the pneumatic tool in the cutting of Bedford stone. The largest hammer that we have ever employed has been the 1-inch hammer. We use regularly the $\frac{3}{4}$ -inch hammer. The 1-inch hammer was bought for a special occasion and is very seldom used.

In all of our experience we have never yet had a complaint from any of our stonecutters against the use of the air hammer on Bedford stone; nor have we ever had a complaint from any of our cutters that the use of the air hammer generated a dust peculiar to the hammer that also was injurious to any of them.

The agitation against the use of the air hammer by certain stonecutters and officers is in line with the agitation of the printers against the first typesetting machines that were brought out. Their complaint against the air hammer is, in our opinion, unjust and unfounded and is in line with their determination to control the machine cutting tools used for the production of cut stone. We believe the time will come when the operators who desire to control their own business and produce stone as cheaply as possibly will be forced to disregard the agitation against these pneumatic tools, and also the agitation in the same line against the use of stonecutting machinery in general.

While the stonecutters' association is called "Journeyman's Association" of stonecutters the word "journeymen," in our estimation, does not apply to the stonecutters of the present day. It was a term properly applied to the stonecutters formerly who went from one job to another to cut the stone on the job. The modern-day process of cutting and preparing the stone at the site of production has changed the character of the stonecutter, and, instead of being a journeyman to-day, he is one of our local property-owner residents. In our own locality we count among our most stable citizens a majority of the stonecutters cutting Bedford stone here. It is their desire, as we freely believe and as was shown by a recent vote of the organization here, to disregard the request to discontinue the use of the pneumatic tool in this territory. Some of the stonecutters here have advised us that if the pneumatic tool were taken from them they would quit the business, claiming that the wielding of a heavy hammer or mallet all day is much more severe on them than the use of the pneumatic tool, and also claiming that they can not possibly accomplish as much by the use of the hammer and mallet as they are now accomplishing by the use of the pneumatic tool.

For all of these reasons we desire to register our protest against the representations made to your bureau, that the pneumatic tool is injurious to the stonecutter in any way.

Believing that the cost of production would be very materially enhanced if the pneumatic tool were taken away from our cutters, we trust that a full and impartial investigation of this pneumatic tool will show your bureau that it should remain in use among the stonecutters.

REPORT OF INVESTIGATION MADE IN NEW YORK.

Following is a letter from an employer, inclosing an article published in the January, 1917, number of *Stone*. The article is given

here because it describes an investigation made in New York as a result of the Indiana workmen's complaint:

We have your letter of February 6 and have carefully noted contents thereof in reference to the supposed injurious effect of pneumatic tools on the operators thereof.

We do not know that we can give any conclusive evidence in this matter further than to state that thousands of these tools are in use throughout the New England granite districts and elsewhere, and we have yet to hear of the first case where they have proved injurious to the operator for any cause whatever, unless it might be possible that the stone dust, which the operator inhales more or less, might be the cause of some scattered cases of tuberculosis, although of this there is no proof.

We are inclosing herewith a clipping from the publication *Stone* of January, 1917, which contains an article in reference to this particular point which you bring up, and we do not know that we could say anything regarding it that would be any more to the point than the information given in this article.

As regards the number of strokes which the 1-inch tool makes, would advise that as near as we can get at it, it delivers about 3,000 per minute.

AIR HAMMERS AND HAND TOOLS.¹

The International Cut Stone Contractors' and Quarrymen's Association of North America has been conducting a very careful and diligent investigation of the charges made by the officers of the Journeymen Stone Cutters' Association that the air hammer is injurious to the health of the users. Some of the results of the inquiry are reported in the monthly leaflet issued by the association. Instances have been found where some of the fingers on the hand guiding the hammer show poor circulation, and in freezing weather are more or less sensitive to the cold, but a case of paralysis of the arm, or as charged, a man being driven insane, or incapacitated in any way, has not been discovered. In New York City, where the air hammer is used in the stone industry probably more extensively than in any other city, a complaint has never been recorded against its use, and out of 100 stonecutters interviewed on the subject during the past three weeks, 97 favored the air hammer. In the Brooklyn Navy Yard the hammer is used very extensively for riveting and chipping, and there has never been a complaint registered against its use.

The structural-iron workers use it in the erection of the steel and structural-iron work, and the only complaint made by them was that they thought they should receive greater compensation when using the hammer, as they accomplished five times the work with the air hammer as they did by hand. At the works of the New York Ship Building Co. at Camden, N. J., there are in use at the present time over 1,000 air hammers, and there is no record of any such effect as complained of by the stonecutters' union, and the employees have never made complaint against its use. At these works, as also at the Brooklyn Navy Yard, all riveting, chipping, and calking is done with the air hammer, and the hammer used is very much heavier and more powerful than the hammer used by stonecutters and carvers.

The investigation, as far as it has progressed, has found that where injury to the user of the air hammer has occurred it has been caused by ignorance of its use. If there are any ill effects from the use of the air hammer it is caused by vibration, and the man using the hammer should be educated to hold the hammer in such a manner as to incur as little of the vibration as possible.

¹ Published in *Stone*, January, 1917, p. 23.

and he should not try, or be permitted, to do work with the air hammer for which it is not adapted.

Mr. James B. Gillie, of the South Dover Marble Co., a gentleman of the widest experience in the stone industry and one who has given a careful study to all the problems of the trade, writes that he has found that the use of the pneumatic hammer has been of great benefit to the trade and of no injury to the employees using the same, provided that the pneumatic hammer is used for the purpose it was intended to be used for, viz, the finishing or lighter work done in our trade. Personally, I have had experience with the pneumatic hammer since it was first introduced into New York City, about the year 1901. I have seen it used on all kinds of stone used in the construction of buildings. I have personally interviewed men who have used the pneumatic hammer since it was first introduced into New York City, and they agree with me that it has been of great benefit to the trade and of no injury to the employees using it. The only complaint I have heard caused by the use of the hammer was that "sometimes in the winter the hands are cold," but when I asked the question, "Are the hands any colder when using the pneumatic hammer than they are when using the mallet and chisel?" I was informed that there was practically no difference. Like all new inventions, there are apt to be abuses caused by the improper use of the invention or by neglect of other implements that were used prior to the introduction of this tool. The fact that the pneumatic hammer and the necessary tools for the same are generally furnished by the employer has given excuse to the employee to neglect the tools that he should furnish, and it is a very frequent sight to see an employee come to work with a mallet that has long outlived its usefulness and a few tools that are but stumps and should be thrown into the scrap heap or made into plugs.

Another abuse of the pneumatic hammer is allowing apprentice boys to use it before they are thoroughly familiar with the use of the mallet, chisel, hammer, hammer points, and pitching tools. The consequence will be that in a very short time new mechanics will be unable to use the tools that have always been deemed essential to the cutting of stone. The pneumatic hammer and tools as an adjunct to the old time-honored tools of the stonecutting trade are a very decided improvement, but the fact should be brought forward that the old and new must work together; if a mechanic is thoroughly acquainted with both he will be a much better employee.

I think some definite action should be taken on the question of what tools an employee should have when he starts to work as a stonecutter, and I have given the matter considerable thought. I think that the smallest number that it is possible for a competent stonecutter to work with is as follows: One tool box or chest, 1 square, 1 bevel, 1 scriber, 1 pair compasses, 1 2-foot rule, 1 light-weight mallet, 1 driving mallet, 1 hammer 3½ to 4 pounds, 1 pitching tool, 18 hammer points, 8 ½-inch chisels, 6 1-inch tooth chisels, 8 2½-inch tooth chisels, 8 droves, 7 splitters, 1 pneumatic hammer, 8 ¾-inch chisels for pneumatic hammer, 8 drafting tooth chisels for pneumatic hammer, 2 splitters for pneumatic hammer, 2 2½-inch tooth chisels for pneumatic hammer, 2 droves for pneumatic hammer. All of the pneumatic tools and the pneumatic hammer to be furnished by the employer. The balance of the tools in the above list to be furnished by the employee.

REPLY OF JOURNEYMEN STONE CUTTERS' ASSOCIATION.

Dr. Joseph L. Miller, of Chicago, wrote to Dr. Emery R. Hayhurst, of the Ohio State Board of Health, mentioning a case of what he diagnoses as Raynaud's disease in one of his patients, a stonecutter,

and inclosing a letter from Mr. Walter W. Drayer, general secretary of the Journeymen Stone Cutters' Association. Mr. Drayer's letter is of special interest in that it states the answer of the stonecutters' organization to the findings in the New York investigation described in the *Stone* article.

The correspondence is given below :

CHICAGO, ILL., *January 2, 1917.*

Dr. EMERY R. HAYHURST,

Ohio State Board of Health, Columbus, Ohio.

DEAR DR. HAYHURST: A few weeks ago I saw a case which interested me very much. This gentleman had been working for a number of years with a power cutting device used for stonecutting purposes. He had developed a typical Raynaud's disease of the hand which he had used in the work. He told me this was very common among these workers, and he gave me an address to write to where I could get more accurate information. I am inclosing you the letter received from this source.

It seems to me this is a most interesting problem as well as one of great importance, because the man I saw, I suspect, will be permanently disabled. I thought perhaps you might be interested in this question. Perhaps you are already familiar with it and might be able to put some one on it to make further investigation.

I wish, after reading over the letter, you would return it to me, as I wish to keep it on file.

Yours, sincerely,

JOSEPH L. MILLER.

CHICAGO, ILL., *December 16, 1916.*

Mr. WALTER W. DRAYER,

Indianapolis, Ind.

DEAR SIR: I recently examined a stonecutter who worked with a power cutting device; he showed peculiar disturbance of the circulation of the fingers. This subject interests me, and he told me that I could probably obtain some information from you regarding the frequency of this condition, etc. Could you furnish me with any reference to the literature on this subject?

Sincerely,

JOSEPH L. MILLER.

INDIANAPOLIS, IND., *December 19, 1916.*

Dr. JOSEPH L. MILLER,

Chicago, Ill.

DEAR SIR: Replying to your favor of the 16th instant, will say that the power cutting device used for stonecutting purposes to which you refer is the pneumatic tool or air hammer. I regret that I do not have any literature bearing upon the detrimental effects suffered by the mechanic who uses this tool for cutting stone. I inclose cut of one of these tools which will give you an idea of its size, etc. It is operated with compressed air under a pressure of 80 to 100 pounds.

This tool is used in the place of the stonecutter's mallet and hammer, the chisel fitting into the hammer being handled in the same manner as it must be handled by the mechanic when cutting the stone with a mallet and chisel.

During the past two or three years this hammer has been universally installed in what is known as the Indiana oolitic stone belt, comprising the cities of Bedford, Bloomington, Ellettsville, and Stinesville, Ind., where are located many of the largest cut-stone plants in the country.

Our experience with the tool is that anyone who uses it for stonecutting purposes suffers a partial paralysis of the circulation, first in the left hand, or the hand that holds the chisel, and in a number of instances in both hands. Some men are affected in two or three months, while others do not notice the effects for a longer length of time. The constant vibration connected with the use of this tool in the manner in which the mechanic is compelled to use it for cutting stone produces a feeling of numbness, perhaps better described by illustrating or comparing it to the feeling one has when his foot or hand goes to sleep. While the operators to whom we have complained of the detrimental effects of the use of this tool deny that it injures the user, yet one has only to go into the oolitic stone belt of Indiana at any time when the thermometer is registering 30° above or lower and he can pick out a hundred of the men who use this tool, and no further investigation need be made to prove that this tool will physically ruin the man who uses it. In many of these shops in the Indiana district the stonecutter is compelled to use this tool eight hours a day, with all the power that lays behind him, and if he complains that the hammer is ruining his physical well-being and attempts to cut stone with the mallet and chisel, even though he might be able with these tools to produce the same amount of work, he is promptly advised that his services are no longer required. From this you will note that even though the mechanic, realizing that the constant use of this tool is ruining his physical well-being, endeavors to protect his health by using the tool but intermittently or for a portion of the day only, he is not permitted to do so by the employer, who seems to have no regard even for humanitarian measures.

This question has been a live issue with our organization for the past three or four years, and we find it difficult to obtain any literature on the matter for the reason that air tools are used in other trades where they are not handled in the same manner and where they do not produce these detrimental physical effects that they do when used for stonecutting. Our members, too, fearing that should they come out and condemn the hammer as individuals, will be discriminated against by the employer, will not individually submit complaints as to the injuries they are suffering from this tool.

I can perhaps best describe the detrimental effects of the use of this tool by my own personal experience with it. Some six or seven years ago I used this tool for carving and other light work upon a Vermont marble job, which marble is considerably harder than the stone used in the Indiana belt (we find that the harder the stone the easier it is on the mechanic, and that one does not feel the effects of using the tool so rapidly on hard stone as he does on soft stone), and although I used the tool but a matter of six or eight months, my hands to-day, especially on a morning when the thermometer is around freezing, are numb and have the appearance that life has left the hand entirely. When I noticed the effect of the use of this tool upon my hands I consulted my family physician, a most capable and efficient surgeon, and he advised me that the constant vibration of this tool had brought about a paralysis of the circulation leading down into my hand and fingers. This paralysis of the circulation is not temporary or suffered only during the time the mechanic uses the tool, as is proven by the fact that though I have not touched one of these infernal tools for the past four or five years, I am still troubled with the numbness and lack of circulation in my left hand, which is not only annoying, but proves a great hindrance in the performance of my present duties. My left hand and fingers

are in this condition most every morning when I reach the office, and many times it takes from one to two hours to get the circulation again started and the hand and fingers again normal.

We have complained frequently, when in conference with the employers' association, of the detrimental effect suffered by our members compelled to use this tool, and have sought to have them investigate the matter and in some way restrict the use of this tool so as to partially eliminate its injurious effect, and they did agree to make an investigation and consider some method in this direction.

I may say that we recently learned that they instituted an investigation in New York City, first among the stone yards where the tool is used in a half humanitarian way, in no comparison to the manner in which the men in the Indiana stone belt are compelled to use it and where the injurious effects are most noticed, and they proudly boast that they found no serious results in this investigation from the use of this tool. Not only did they investigate the tool in the stone shops in New York, where the employers take some precaution looking toward eliminating the injurious effects of the use of this tool, but they extended their investigation to the Brooklyn Navy Yard, the New York Shipbuilding Co.'s works, and on structural-steel work. As I have stated above, the tool when used by mechanics in these callings is used in a far different manner than when it is used for stone cuttings; in fact, the operator handles the hammer with both hands, does not hold a chisel inserted in the hammer as does the stonemason, and the tool does not produce the injurious effects to anywhere near the extent it does in cutting stone. If the employers' association were in earnest in their investigation and would be fair, they would have started their initial investigation in the Indiana stone belt, and we have no other evidence to offer these but to produce any number of mechanics up to 150 or more and submit proof positive that this tool does ruin the physical well-being of the man who uses it.

I am pleased to know that you are interested in this matter, and should you wish to make further investigation, I would be only too pleased to cooperate with you. It is a matter of but a few months when an investigation will be made by some one regarding the effects of the use of this tool, as bills will go before the various State legislatures in the very near future seeking its complete abolishment as a stonemason's tool.

Trusting I have given you a clear idea of the evil results from the use of this tool, and assuring you that I shall be pleased to answer any further questions upon the subject, I am,

Yours, very truly,

WALTER W. DRAYER,
General Secretary.

CHICAGO, ILL., *January 2, 1917.*

MR. WALTER W. DRAYER,
Indianapolis, Ind.

DEAR MR. DRAYER: I was very much interested, indeed, in your letter. It seems to me this is a very serious problem and should be investigated. I have taken this matter up with a friend of mine, who is interested in industrial medicine, in the hopes that he might have some one to put on the problem.

The man I saw here before writing you certainly had a very serious disability, which I am rather fearful will be permanent. If I hear anything further regarding this matter from the doctor to whom I have written I will let you know. Meanwhile let me thank you again for the letter giving a full account of this condition.

Yours, sincerely,

J. MILLER.

PART II.—RESULTS OF OFFICIAL INVESTIGATIONS BY PHYSICIANS.

REPORTS OF PHYSICIANS FOR THE BUREAU OF LABOR STATISTICS.

A STUDY OF SPASTIC ANEMIA IN THE HANDS OF STONECUTTERS.

BY ALICE HAMILTON, M. D.

In March, 1917, Dr. Joseph L. Miller, of Chicago, called my attention¹ to an unusual occupational disease in a stonecutter from the Indiana limestone region, who was accustomed to use the air hammer in his work. The man complained of attacks of numbness and blanching in certain fingers, coming on suddenly under the influence of cold and then disappearing again. When he called on Dr. Miller for advice he had no visible signs of the trouble, but from the description he gave Dr. Miller believed it to be a form of Raynaud's disease and he thought that since there were said to be many similar cases in the limestone region it was a condition that

¹ The letter is printed in full below :

MARCH 19, 1917.

Dr. ALICE HAMILTON,
Chicago, Ill.

DEAR DR. HAMILTON: I thought you might be interested to know the history of this Mr. McBairdy, whom I saw here at the office on November 18. He is 32 years of age, of good family history, smokes about 10 cigars daily, is a very moderate user of alcohol, has worked nine years holding this air-driven drill, and he has held it in his left hand. Two or more years ago he first noticed that the little finger and the adjacent one on this hand became pale and numb when using the instrument in cold weather. This trouble has gradually increased until at the present time in cold weather, when he is not working, these fingers on the left hand become numb and turn white; in other words, present all the symptoms of Raynaud's. In summer he has no trouble, even when working. He stated that he had worked at this but five years before the trouble began. He stated to me also that some of the men who worked with this instrument developed paresis of the entire arm, and he complained some of his arm being painful and somewhat weak.

Physical examination, including the blood pressure, showed nothing abnormal. I thought you might be interested in this brief report.

I believe it would be very interesting in these cases to note whether there is any difference in the appearance of this trouble in a man who is a heavy user of tobacco, inasmuch as that has always been considered a possible factor in Raynaud's, and also to note what fingers are first involved, and to see whether it is associated with any marked thickening of the radial arteries.

Please excuse me for making these suggestions, but the problem appeals to me as such an interesting one that I have given it quite a little thought. If, after you get started in your work down there and get the patients lined up, I can be of any assistance I shall be glad to run down to Indianapolis for a day so as to go over the clinical side of this condition with you.

With kindest regards, I am,
Yours, sincerely,

J. L. MILLER.

merited close study. The Bureau of Labor Statistics had made a preliminary inquiry into the matter and found that the limestone cutters do suffer from "dead fingers." Later it was reported that granite and marble cutters do not suffer from this affection. This was denied by the men. The bureau authorized me to visit the limestone belt of Indiana, the granite-cutting centers in Quincy, Mass., and Barre, Vt., the marble shops of Proctor, Vt., Long Island City, and Baltimore, and the sandstone mills of northern Ohio.

Since the condition in the men's hands which was the object of this inquiry comes on under the influence of cold, I made my visits during January, February, and March of 1918 on days when the temperature was between 14° F. and 34° F. I discovered a very clearly defined localized anemia of certain fingers which is undoubtedly associated with the use of the air hammer and which, while it lasts, makes the fingers numb and clumsy, causing the workman more or less discomfort and sometimes hampering his work.

The pneumatic hammer consists of a handle containing the hammer, which is driven by compressed air and is said to deliver from 3,000 to 3,500 strokes a minute. The amount of air delivered through a hammer can be controlled by a valve in the pipe conveying the air, and the air escapes through an exhaust opening in the handle itself. This handle is held in the right hand in various ways, sometimes with the palm of the hand down and all the fingers grasping the handle equally, sometimes with the palm up and the grasp exerted chiefly by the thumb, index, and middle fingers; it may also be held between the thumb, middle, and index fingers, very much as a pen is held. Hammers are of various sizes; there is the small half-inch, the medium five-eighths or three-fourths inch, and the large 1-inch hammer. The tool (the chisel) is held by the left hand against the hammer, with the cutting edge pressed against the stone. Italian workmen usually slip the tool between the little and ring fingers, so that it rests against the side of the little finger, where a large callus develops. Other workmen grasp the tool with all four fingers. In either case the little and ring fingers, being nearest the cutting end of the tool, are pressed most closely against it in order to guide it.

The conditions under which stone is cut differ somewhat for the four kinds of stone. In the limestone region of Indiana and in the sandstone region of Ohio there are large mills heated somewhat in winter, so that the temperature is perhaps 10 or, rarely, 20 degrees higher indoors than outside. This would mean that when the thermometer stands at 15° F. the working atmosphere will be at about freezing point or perhaps as high as 38° F. In Quincy and in Barre, granite is cut in sheds, which in the former town are wide open, but in Barre are inclosed and sometimes slightly warmed. They are, however, colder than the western mills and in very cold weather work

has to be suspended. The marble shops are inclosed and usually better heated than any of the other stonecutting shops I visited. I did not see a place in any mill or shed where a man could warm his hands conveniently.

The air hammer is used in cutting all four kinds of stone, but not to the same extent in all. Limestone cutters use it almost all the time. When one enters a mill in the limestone region the stonecutters, with a very few exceptions, are all seen to be using the air hammer. It is rare to see more than two or three men wielding the mallet, unless they are apprentices who are required to use it.

In cutting limestone the air hammer can be used both for shaping the block of stone, a process known as roughing out, and for cleaning up or making a smooth surface. Many men say that the roughing out should really be done with the mallet, but in practice the air hammer is used. Limestone cutters use all sizes of tools; the carvers use the smaller ones chiefly or entirely. Marble cutters come next in their use of the air hammer. They work more with the mallet than do the limestone men, but the greater part of their work is with the pneumatic tool and usually the smaller sizes, the half or three-fourths inch tool.

Granite cutters can not use this tool for shaping the block. That must be done by hand, because the stone is so hard. For dressing the surface they use two machines, a large heavy surfacer with a big handle, which is grasped in both hands and held upright, the tool pressing on the surface of the stone; and a smaller "bull-set" or "four-point," which also has a fairly large handle and a short tool, and which is also held perpendicularly in both hands and pressed against the surface of the stone. The tool in both these machines is held in place by the hammer and stone, never grasped or guided by the left hand. For lettering and carving, however, the granite worker uses the same sort of air hammer as is found in marble and limestone mills, and there are granite workers who use it all day long, but these are the exception. As a rule the men I questioned in the granite sheds use it only four, five, or six hours a day.

In sandstone the air hammer seems to be of little use. A mill I visited near Amherst, Ohio, had five air hammers for 30 men, and that number was quite sufficient. Sandstone does not require much tooling. It is used chiefly for paving stone, curbstones, grindstones, and exterior building stone. Much of the tooling required is done by hand, for the nature of the stone makes work with the air hammer difficult or impossible. I questioned 15 sandstone cutters and was told by 6 that they had never used the air hammer at all. Two had formerly used it in marblework, but not in sandstone, and 7 used it now and then for sandstone, but hardly more than half an hour during the day.

DESCRIPTION OF STONECUTTERS' WHITE FINGERS.

The trouble which I found among the limestone cutters, granite workers, and marble carvers is not Raynaud's disease. It is a spastic¹ anemia, affecting the arterioles of the fingers and hands—it comes on in sudden and recurring attacks under the stimulus of cold as does Raynaud's syncope,² and the pallor is much more pronounced, but it is not succeeded by the stage of extreme asphyxia so characteristic of Raynaud's—it is not symmetrical, even when in both hands, and it does not result in the wasting and death of tissue which accompany Raynaud's. I did not see any marked swelling or excessive congestion, or severe pain. Nor did I see hands with thickened fingers or deformed nails; on the contrary these stonecutters had well-formed and well-preserved nails such as one seldom sees in manual workers. No history was given me of necrosis³ or blisters or ulcers or desquamating skin,⁴ and the pain complained of was nothing like so severe as that often experienced in Raynaud's disease. As to the distribution of the vascular spasm, this is not capricious as in Raynaud's but apparently determined by definite causes. It is not really symmetrical. The left hand is usually the only one affected, and when the right hand suffers the fingers involved are not the ones corresponding to those involved on the left hand.

The examination which I was able to give the men in the absence of all laboratory equipment established the fact of a spastic anemia undoubtedly of occupational origin and accompanied by certain more or less definite sensory changes which sometimes persist to a lesser extent between the attacks. I could not determine how great the latter are nor whether there is any real impairment of the function of the affected hand. That part of the investigation was undertaken in Chicago by Dr. Thor Rothstein, whose report follows mine.

A description of one or two of the more marked cases will show just what this condition is. The first is a limestone cutter whom I saw early in the morning when the temperature was about 14° F. He had been out of doors for over half an hour and in order to be able to show me his hands in a typical condition he had refrained from rubbing them violently and swinging his arms about, as he would ordinarily do to restore the circulation. The discomfort, however, had grown so intense in his fingers that he could not bear it any longer and almost at once after I arrived he began rubbing and kneading and shaking his hands. The four fingers of his left hand were a dead, greenish white and were shrunken, quite like the hand of a corpse. The whiteness involved all the little finger to the

¹ Characterized by spasms.

² Sudden pallor and insensibility.

³ Death of cells surrounded by living tissues.

⁴ Falling off of the cuticle in scales.

knuckle, but in the other fingers it stopped midway between knuckle and second joint. As he rubbed his hand the contrast between fingers and hand increased and at one stage it was very striking, the crimson and slightly swollen hand meeting the white shrunken fingers abruptly, without any intermediate zone. On the palmar side the condition was not so distinct, for the skin was too thick and calloused to allow the color to show well.

The right hand was much less affected, the little finger escaped altogether, the three others were white, but not dead white, as far as the second joints, and there was a ring of white around the second phalanx of the thumb. After vigorous massage and beating of his arms back and forth over his chest, the blood gradually filled the fingers and the appearance then was fairly normal, showing only a moderately purplish red color, and no swelling.

This man is 39 years old and has cut stone for 22 years. While using the ordinary tools of his trade he had no trouble of this kind. Nine years ago he began to work with the air hammer and during the second winter after that he noticed that the ring finger of the left hand had begun to "go white." Gradually the little finger became involved, then the others, and, to a less extent, the fingers of the right hand. The trouble has progressed through the years and is still increasing. There is a good deal of pain in the fingers, especially on a cold morning. As long as the dead-white condition lasts there is no real pain, but discomfort enough to make him stop work and get the blood back into his fingers, for the stroke of the hammer on the tool he holds in the left hand is peculiarly intolerable when the fingers are white. As the blood comes back there is some sharp pain but it does not last. At no time, however, does the left hand feel quite natural, he is always conscious of it; indeed his whole left side, including the foot, feels differently from the right. If he holds his hands up for a few minutes they grow numb and this is annoying when he tries to read a newspaper and must continually put it down to coax the blood back into his hands. He has lost sensitiveness in the fingers, so that he can not put his left hand in his pocket and pick out a coin by the touch; he must look at it to see if it is a dime or a nickel. He is clumsy in the morning when buttoning his clothes and lacing his boots. If he works all day with the hammer he has a restless, disturbed night.

The second man is a marble cutter who has followed his trade for 20 years and has had trouble with his fingers from the fifth year on. He uses the small tool almost entirely. The four fingers of the left hand were white, the little finger over the whole extent, the next two over the two distal joints, the index over the first joint. On the right hand the tips of all four fingers were white and there were irregular streaks of white along the index and middle fingers. This

man complained of the pain in his fingers both when they were white and when the blood first began to come back, but his chief complaint was of nervousness from the vibration of the hammer; he said it upset him, made him "as nervous as a kitten," spoiled his sleep, made him irritable. Though he is troubled chiefly in winter, he can not put his hands in cold water in summer without making his fingers "go white." In winter, if he is working indoors he is not really hampered by the numbness in his fingers, but he can not do any fine work out of doors if the weather is at all cold, for the numbness makes his fingers clumsy.

The third is a granite cutter who has used the air hammer for 18 years and who began to feel the effects in his fingers after two years. Now his left hand shows all of the little, ring, and middle fingers involved and all but one-third of the index finger. On the right hand most of the index and middle fingers and the tips of the ring and little fingers are blanched, but not so strikingly so as the fingers of the left hand. He is "bothered" a good deal by the numbness in winter, and it comes on whenever he handles a cold tool, after which he finds it hard to do any fine work till he has managed to get the circulation started again.

There is no need to multiply these descriptions. With a few variations the men from whom full histories could be obtained told much the same tale, though the majority had not suffered as much discomfort as had these men. These stonecutters are exceptionally good material for such a study, for they are intelligent men, usually of good education and able to note and describe their symptoms clearly. There is among some of them a tendency to dwell perhaps too much on the nervous disorders which they believe are caused by the tiring vibrations of the hammer, and which give them a good deal of worry. Of nearly all of the men this is not true. Many of them have no complaint at all, except of the actual condition in the hands, but others suffer from more or less distressing symptoms which they think are caused by the vibrating hammer. The most common symptom is covered by that vague term "nervousness." They say that they feel jumpy and irritable, upset by a slamming door, and unable to settle down after a full day's work with the tool. Their sleep is disturbed and restless, and they have buzzing or ringing in the ears. The numbness in the hands is inconvenient, for they can not hold a newspaper or a book for any length of time without being forced to put it down and rub and knead their hands. Sometimes they have to sleep with the left arm hanging down from the bed or the numbness will waken them, and then they must get up and swing the arms about or bathe the hands in hot water. Some of them are not troubled at all in summer, others get numb fingers on chilly days or if they put their hands in cold water. A few men

complain of trouble with the left foot, which is colder than the right.

The local changes are surprisingly similar in all these cases. There is no capricious localization of the anemia. Invariably the little finger of the left hand is affected, never, so far as I saw, the left thumb, though a few men said they believed it did sometimes "go dead." If one finger on the left hand escapes, it is the index finger. The most usual distribution is over the little and ring fingers, part of the middle finger, and somewhat less of the index on the left hand, so that the line between the pale and red portions runs diagonally from the knuckle of the little finger to the first joint of the index. Sometimes there is a spot of white in the center of the left palm. The right often escapes entirely, so far as evident signs go, and when affected it is less strikingly so than the left, and the anemia is less uniform in its distribution. The right thumb is sometimes involved, the index finger often, but the other fingers are hardly ever pale except at the tips.

There were two men who surprised me by displaying left hands with anemic finger tips and right hands with anemia of all four fingers, but both proved to be left-handed and they use their hands accordingly, holding the tool in the right hand and the hammer in the left. Many men told me that the white area on their hands sometimes extended as far as the wrists on the ulnar side, but I never saw it reach even quite to the knuckles.

Usually the men say that the blanching of the fingers is most marked early in the morning and passes away more or less while they are at work with the hammer, returning in the afternoon when work is over. I examined a little over 100 soft-stone, marble, and granite cutters at work and could actually see the pale fingers in only 22, but among 23 men I saw away from the plants 16 showed the condition quite strikingly after they had exposed their hands to the cold for a few minutes. Among those who came to see me at the hotel there were some whose hands grew warm fairly quickly and appeared quite normal after they had been in the room a short time, but in other cases a decided difference persisted in the color and temperature of some of the fingers of the left hand as compared with other parts of that hand and with the right hand. Several men told me that there was always some difference in the feeling of the two hands. Men who had had attacks of white fingers could always bring the condition on by washing their hands in cold water or going out of doors for a while.

In several cases there were no local patches of anemia but the left hand looked smaller as well as paler than the right. In fact one marble worker showed a very striking difference in the size of the two hands. Another marble worker showed the reverse condition, a

paler and smaller right hand, but this man proved to be left-handed. I also heard from two former granite cutters, now employers, a history of wasting of the muscles of the hand from the use of the air hammer. One of these men used the air hammer for 20 years and after the first 2 years the fingers on the left hand began to get white, but later on he noticed that the interosseous¹ muscles of this hand were wasting and deep hollows appeared between the thumb and index finger and between that finger and the next. He gave up the work and the hand gradually went back to its normal state. The second man's history was similar, only that he had the wasting in his right hand, being left-handed and holding the tool in his right hand. He, too, recovered entirely after leaving the work in the shed.

I tried to discover whether this condition persists even after a man has left the trade of stonecutting, whether in cold weather he still has attacks of blanched, numb fingers. There are a few men still working at the trade who say that it passes away gradually; that they used to be much more troubled by it than they are now. On the other hand, I found several men who are no longer cutting stone, who gave up the trade several years ago, and yet still have numb, white fingers at times in winter or if they try to work with cold metal. I will give the essential points in the histories of eight such men.

The first was a granite cutter for 20 years, but left the trade eight years ago. Three fingers of his left hand still get blanched and numb in winter. The second, also a granite worker, stopped work eight years ago but still has the condition at times in the fingers of the right hand (he is left-handed). The third left granite cutting 12 years ago, after four fingers of the left hand had become affected, and those fingers grow white now in winter. The fourth, also a granite worker, came into the office of the union while I was there, and I noticed at once the dead-white, shrunken condition of his left hand, very characteristic and marked. He told me that he was no longer cutting granite; had not done it for four years, yet the condition persists. Two limestone cutters left the trade six and eight years ago, but both have numb, white fingers on cold mornings. Two marble workers are now cutting sandstone after some years in the marble trade, during which time they suffered from white fingers, and though it is now 10 years and more since they ceased to use the air hammer, they still have traces of the trouble.

It is very important to know whether this condition of the hands affects the men's skill or strength, whether it lessens their earning capacity in case they wish to take up other work than stonecutting. I can not speak with any positiveness as to this, but the tests made by Dr. Rothstein throw some light on the question. Few of the men

¹ Between the bones.

whom I saw complained of loss of sensation in the fingers great enough to hamper them, except when the fingers were actually numb. The majority noticed no change at all in the intervals between attacks of numbness. But, of course, an occupation which had to be carried on in the cold might be impossible just because the numbness would inevitably come on. For instance, one man had tried to work in an automobile repair shop, and found that on a cold day he could not pick up or hold small screws or small machine parts with his left hand. Another had taken up work which involved handling a crowbar sometimes, and when he did this in winter his left hand would grow numb and so clumsy that he could not use it with skill. The only men who complained of clumsiness in their own work from numb fingers were marble workers who require a high degree of skill, and who find that cold weather often makes it impossible for them to do their best work, especially if they are out of doors.

To understand why the left hand is most affected by the air hammer, one has only to experiment with it. I tested several hammers, from the small light one used by the carvers to the heavy 1-inch hammer. At first the vibration in both hands is so severe to an unaccustomed person that it is impossible to distinguish much between them, but presently one finds that it is possible to hold the hammer in the right hand without grasping it tightly, while the tool held in the left hand must be clung to with much more force or the blows of the hammer will drive it from the hand. This tool receives the direct blows of the hammer, delivered, I was told, over 3,000 times a minute. The handle of the hammer is large and easy to hold, while the tool is small and the fingers are usually cramped about it, which of course drives the blood out of the fingers of the left hand. It is this hand also that does the cutting, guiding the tool along the surface of the stone. The little and ring fingers are pressed against the tool especially close to do this guiding. It did not take me long to become convinced that the effect of the air hammer is greater on the left hand than on the right. The effort expended is greater, the muscles are more cramped, and the vibrations are more violent.

This test of the air hammer explains also why the right hand is less uniformly affected than the left, some men having no trouble at all with it. The work done by the right hand admits of more variety than that done by the left. The handle may be held in several different ways and the strength of the grip relaxed sometimes. Some men find it possible to relieve the right hand by winding a pad or slipping a piece of hose around the handle, deadening the vibration and protecting the hand from the cold steel. It is true that the right hand does sometimes get the force of the cold air from

the exhaust which issues in a sharp blast, freezing cold, from an opening in the handle of the hammer. Some men get this blast on the right thumb or index finger, because in doing certain kinds of work they like to vary the force of the blows from minute to minute, and they can do this by controlling the exhaust with the thumb or finger. The control is usually exerted through a valve lower down in the pipe, which is really the proper way to manage it. However, even when a man does control the exhaust with his thumb or finger, he does not have as much anemia in the right hand as in the left.

PREVALENCE OF WHITE FINGERS AMONG STONECUTTERS.

Spastic anemia of the fingers is found to some extent among all the four classes of stone workers, with the exception of those sandstone cutters who have never worked in any other sort of stone.

The first region I visited was the limestone belt of Indiana,—the towns of Bloomington and Bedford. There I was able to examine 21 men who came to the hotel to see me and 17 who were working in the mills at the time I went through them. In Quincy and Barre I saw 50 granite cutters, all but 3 of them at work in the sheds. I examined 78 marble cutters at their work in Proctor, Long Island City, and Baltimore, and 15 sandstone cutters in a mill near Amherst, Ohio. In all 181 stonecutters and carvers were examined.

Among sandstone cutters spastic anemia of the fingers is not found. I visited a mill in which 15 men were at work at the time and the only ones who had ever had dead fingers were three former marble cutters. They had used the air hammer in marble work and their fingers had shown the effects, but in working with sandstone they had used it so little that the trouble was passing away. The other 12 either used it not at all or very little. This is the rule in sandstone work and the result is that dead fingers are not found among the men in this branch of the stone trade. I found also three marble workers and one granite worker who had not used the air hammer and who also had had no trouble with their fingers.

In limestone, granite, and marble work, the condition is so common that any inquiry about it meets with instant response. One does not have to stop to explain. In Quincy and in Barre many of the granite workers are Italians who speak little English, but as soon as they understood my question they would hold up in answer one, two, three or four fingers of the left hand, but often would shake the head when I then pointed to the right hand. It had been charged that the agitation about this condition among the Indiana limestone men had been influenced by the fact that at the time there was a controversy between the employers and the union concerning the use of the air hammer, but there was no controversy in the granite or

marble shops, and yet the testimony given by the men in these two fields was much the same as that given by the limestone men.

On the whole the condition set up in the men's fingers by the use of the air hammer does not seem to be so pronounced among the majority of marble and granite workers as among the limestone cutters. This is true both as regards severity and as regards the proportion of men affected. Among the 38 limestone cutters and carvers there were only 4 who had never had white fingers. About as small a proportion of granite workers had escaped—only 7 out of 50—but the effect was much slower in onset among these men than among limestone workers, most of them having worked 5 years or more before their fingers began to show the effects. This is probably attributable to the fact that granite workers, as I said above, do not usually work all day long with the air hammer; they use the mallet more than do the limestone men. A much larger proportion of marble workers were free from anemia of the fingers—34 out of 78. There were also few men in this last group who complained of the numbness or pain in their fingers or said it made them clumsy or that the vibrations of the machine made them nervous.

I attribute this difference partly to the smaller tool used by most of the marble workers, partly to the fact that marble shops are better heated than the mills and sheds in which the other kinds of stone are cut, and perhaps also to a greater skill in handling the tool, the carver apparently holding it more easily and lightly than the cutter. However, there is another difference which must also be taken into account. Limestone and granite workers belong to a strong union, while all the marble shops I visited are nonunion, and though I hardly like to say that that fact kept the marble workers from answering my questions as freely as did the union men, still it must be admitted that a visit made to a nonunion shop under the guidance of the foreman or manager is not the best way to elicit full histories of occupational disease.

The slighter effect of the small hammer used by carvers was illustrated in one marble shop where among 12 men who used it only 1 had had white fingers, while among 18 who used the large hammer 12 had had this trouble.

The men who show no effects from the air hammer usually attribute their immunity to a more skillful use of the tool. They say that they hold the chisel lightly and never cramp their fingers around it, or they wind thick cotton or wool around the left hand to protect it from the cold. However, I have seen blanched fingers in many men who wore thick gloves on the left hand. One marble worker told me that the condition of the machine made a great deal of difference. He always had trouble with his hands if he worked in a shop where they used old hammers and did not keep them in order,

for these grow loose and the tool slips unless it is held tightly, and the vibration is worse. With a new small tool he has no trouble at all. Certainly some men can use the air hammer for long periods and show no effect from it. I saw a limestone carver who had worked with it 23 years, a granite cutter who had done so all day long for 18 years, and two marble cutters who had used it quite steadily for 15 years, and none of them had any numbness of the fingers.

. **CAUSE OF SPASTIC ANEMIA OF THE FINGERS.**

There can be no reasonable doubt that this spastic anemia of the stonecutters' fingers is caused by the use of the air hammer. The more continuously it is used, the greater the number of men affected by numb fingers and the more pronounced their symptoms. The greatest complaint is heard from the limestone and marble cutters who use the air hammer for the greater part of their working time. Granite workers have numb fingers also but they do not seem to experience as much discomfort as do the men in the other two branches, and granite workers do not use the hammer much more than half their time. Sandstone cutters use it little or not at all and this is the one stone trade in which numb fingers are almost unknown. One man only was found in any of the stone trades who had this condition of the fingers and had not used the air hammer, and he had only the tip of his little finger affected.

It is, of course, possible that the same condition might be brought about by the use of the mallet and chisel, for the factors that operate in air-hammer work are present to some degree in work with the mallet—a cold tool grasped tightly by the left hand and vibrating from the blows of the mallet. Only the condition would certainly come on much more slowly and probably never attain the same degree, because handwork can never be as continuous as machine work, it must be interrupted from minute to minute; indeed it is probable that between each two blows of the mallet the hand holding the chisel relaxes slightly. In work with the air hammer the fingers of the left hand grasp the chisel so tightly and so long that I have seen men obliged to bend them back with the help of the right hand after the tool was laid down, they had grown so stiff. It is certainly true that while stonecutters may have had "dead fingers" before the air hammer was introduced, the condition was not at all common or striking.

There seem to be three factors in the production of this vascular spasm—cold, cramping of the fingers, and the vibration of the hammer and tool. As we have seen, cold acts as the exciting cause of an attack, but it alone can not cause the trouble. Frostbite is a totally different condition. The clutch of the fingers around the tool drives the blood out of the blood vessels and anything that makes

it necessary to hold the chisel especially tight seems to add to the numbness and deadness of the fingers. The large tool has to be held very tightly and marble workers find it more trying than the small tool. Old, loose hammers give more trouble than new, tight ones that hold the tool better. The difference in its effect on different individuals is also usually explained by the different way they hold the tool, for if it is held loosely the man may have no trouble at all with his fingers.

It is hard to say how much the vibration has to do with it. Men who suffer through nervousness which they attribute to the use of the air hammer think it is the vibration that has caused it, but as to the effect on the hands, it seems impossible to separate the part played by vibration from the part played by the strong muscular contraction. The tool that vibrates most has to be held tightest, so the two factors act together. Dr. Rothstein regards the vibration as probably the important factor in the causation of the vasomotor and sensory disturbances he found in the men examined.

Because of the fact that the use of tobacco sometimes causes a spastic anemia of a distinctly localized character, Dr. Miller in his letter to me about the patient whom he had seen suggested that this point be inquired into when histories of the men were taken. I could not establish any connection between the use of tobacco, smoking or chewing, and the appearance of dead fingers. The men are not, on the whole, heavy users of tobacco, for smoking at work is generally forbidden and chewing during work is not common. I could not find any indication that tobacco was ever the exciting cause of an attack of white fingers.

German and Austrian stonecutters in the limestone region say that the use of the air hammer in those two countries has been forbidden by law because it was discovered that the men who had used it could not handle their rifles properly when doing their military service. There is nothing in German factory inspection reports to confirm this statement. The last reports accessible to us are for the year 1913, and they show that a pneumatic tool for stonework was introduced several years before this in Germany and its use had increased so much that factory inspectors were instructed to gather information as to its effect on the health of stone workers. No description of the tool used is given, but it is clear that it is a drill for use in quarries, probably a drill for blasting charges and for breaking stone. The machines are worked by steam, compressed air, or electricity.

The inspectors who report on them are concerned with the great increase in stone dust occasioned by their introduction and with the possibility of using water to keep this dust down. Only four times in more than 20 reports is there any mention of the vibration of the

drill. In some places the men are said to use it only a few hours in the day or to alternate with other work. This last precaution is insisted on by the inspector for Wiesbaden in his district. It is very evident that the tool in use is not an air hammer for working up stone. In the report from one district only, Bremen, there is a passing mention of the occasional use of a pneumatic machine in a marble shop.

SUMMARY.

Among men who use the air hammer for cutting stone there appears very commonly a disturbance in the circulation of the hands which consists in spasmodic contraction of the blood vessels of certain fingers, making them blanched, shrunken, and numb.

These attacks come on under the influence of cold, and are most marked, not while the man is at work with the hammer, but usually early in the morning or after work. The fingers affected are in right-handed men the little, ring, middle, and more rarely the index of the left hand, and the tips of the fingers of the right hand with sometimes the whole of the index finger and sometimes the thumb. In left-handed men this condition in the two hands is reversed.

The fingers affected are numb and clumsy while the vascular spasm persists. As it passes over there may be decided discomfort and even pain, but the hands soon become normal in appearance and as a usual thing the men do not complain of discomfort between the attacks. There seems to be no serious secondary effects following these attacks.

The condition is undoubtedly caused by the use of the air hammer; it is most marked in those branches of stonework where the air hammer is most continuously used and it is absent only where the air hammer is used little or not at all. Stonecutters who do not use the air hammer do not have this condition of the fingers.

Apparently, once the spastic anemia has been set up it is very slow in disappearing. Men who have given up the use of the air hammer for many years still may have their fingers turn white and numb in cold weather.

According to the opinion of the majority of stonecutters the condition does not impair the skill in the fingers for ordinary interior stone cutting and carving, but may make it impossible for a man to do outside cutting in cold weather or to take up a skilled trade which exposes the hands to cold.

The trouble seems to be caused by three factors—long-continued muscular contraction of the fingers in holding the tool, the vibrations of the tool, and cold. It is increased by too continuous use of the air hammer, by grasping the tool too tightly, by using a worn, loose air hammer, and by cold in the working place. If these features can be eliminated the trouble can probably be decidedly lessened.

REPORT OF THE PHYSICAL FINDINGS IN EIGHT STONECUTTERS FROM THE LIMESTONE REGION OF INDIANA.¹

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GENERAL REMARKS.

All of the men examined presented symptoms of (1) marked vasomotor disturbances mainly in their hands, and (2) decrease of sensation.

1. The symptoms of vasomotor disturbance were mainly vasomotor constriction (whiteness), with some stasis (blood stoppage) when hands were cold, and vasodilatation (redness) when hands were warm. These disturbances were brought about by different causes:

(a) *Temperature*.—A lowering of the temperature causes a vasoconstriction of the blood vessels of the hand to an abnormal degree. The vasoconstriction was most marked when the hands were exposed to the out-of-door temperature (February) or put into cold water. All of the men after such an exposure had at least some fingers which seemed to be bloodless. An extreme degree of vasomotor constriction must therefore have been present. But even slight changes in the temperature were sufficient to bring about a more or less pronounced vasomotor constriction. For instance, if the hands were kept under the bedcovers until they were warm, and then were put on top of the bedcovers, thus exposing them to the room temperature, they would soon become cold and even assume a more or less marked whiteness. I also observed several times that in the morning before the men had left their beds their hands were cold, bluish red, and the fingers more or less whitish.

(b) *Mechanical stimuli*.—Mechanical stimuli also caused an abnormal vasomotor constriction. If the blunt end of a pencil was dragged, with some pressure, over the skin of the hand a white streak (vasoconstriction) appeared. This white streak did not, as in a normal person, in a few seconds change into a red streak, but remained for many minutes and even spread. Even the stimuli used for testing the sensation, especially pin pricks, after a while produced a marked vasomotor constriction. Under normal conditions pin pricks cause a vasodilatation.

¹ Eight men were examined in Bedford, Ind., during January, 1918, and about a month later they were brought to the Presbyterian Hospital of Chicago for a more detailed examination.

(c) *Galvanic current*.—The galvanic current, instead of bringing on a vasodilatation, caused in the men a more or less marked and lasting vasoconstriction.

2. *Symptoms of decrease in sensation*.—Decrease of the sensation of touch, pain, and temperature was found. In none of the men was this decrease of severe degree. The areas of skin on which the decrease of sensation was found far exceeded those areas which could actually be in contact with the tools used.

As the decrease in sensation was most marked in the areas which presented the most marked vasomotor disturbances, it is logical to assume that the decrease in sensation was a consequence of the vasomotor disturbances. One would therefore expect the disturbances in sensation to vary in some degree with the vasomotor disturbances, for instance to be of different intensity in the summer and winter.

I had opportunity to examine some of the men twice within two to four weeks' intervals in January and February and found the decrease in sensation to be practically the same as to extent and degree at both examinations.

Localization of symptoms.—The abnormal condition of the vasomotor nerves and of sensation was found mainly in the hands, but in some of the men decrease of sensation was found in the forearms. Certain facts point to the possibility of a more general disturbance of the sympathetic nervous system being present. In most of the men the vasomotor reflexes of the skin were found to be livelier than normal in parts of the body other than the hands and arms, and all of the men gave me the impression that they were in general unusually sensitive to the temperature of the air. They would easily shiver, even when in the hospital, and when in bed they would cover themselves up very carefully. It is possible that the functions of the vasomotor system of the whole body were altered to a slight degree.

The men complained about a swelling of the hands. In my notes on the physical examinations I have not mentioned any swelling. There existed undeniably a certain degree of swelling of the hands in all the men examined, but it hardly exceeded what would be expected in men who were doing manual labor in a low temperature. In one case (No. 7) the little finger of the left hand presented a distinctly pathological swelling of the soft parts, the whole finger being of larger circumference than the right little finger.

Several of the men (Nos. 1, 2, 5, 6) had on the dorsum (back) of their hands very few hairs. Some areas of the skin of the dorsal surface of the hands were without a hair. It is possible and even likely that there had been a falling out of the hairs due to the existing vasomotor disturbances, but the number of observations is too small to allow any conclusions to be drawn. The falling out of hairs is, however, met with in disturbances of vasomotor function.

One case (No. 8) showed, at least at times, a marked increase in the perspiration on the palms of the hands. The increased perspiration had, of course, some relation to the vasomotor disturbance, but its significance can not very well be decided upon from so few observations.

In none of the men could any degeneration or real weakness of the muscles be demonstrated, and the electrical reactions of the muscles were normal. If any of the men suffered any decrease in their muscular strength I was not able to detect it. In most of the men the left arm was smaller in circumference than the right arm, but data are too few and differences too small to form an opinion about the relation between the work and the smaller circumference of the left arm.

Urine and blood were examined in all 8 men and in all cases found to be normal.

CONCLUSIONS.

It can be stated that these examinations have demonstrated the presence of marked vasomotor changes and decrease of sensation in the stonecutters examined. The vasomotor nerves of the hands were abnormally sensitive and reacted in a manner never seen in normal conditions. As the sensitiveness of the vasomotor nerves to mechanical stimuli was most marked in the parts of the body which were in closest contact with the vibrating pneumatic tool, it is evident that the vibrations of the tool must be considered as the cause of the vasomotor disturbances found in the men.

No symptoms of a dangerous character were found and the condition can not be said to be of serious consequence to the general health of the men. It is, however, impossible to state that it would not finally have an unfavorable and even serious influence upon the health of the men (or some men). It can not be denied that the condition of the hands of the men I had opportunity to observe is a handicap, preventing them from choosing certain occupations and thereby limiting their freedom.

The figures accompanying the following case histories are exact representations of the changes of sensation in each man. The sensory disturbances varied in intensity from day to day and it would be impossible to give more than an approximate description of the degree of change. The character of the disturbances, however, and their localization are depicted with a very fair degree of accuracy.

The tests were made while the hands were warm and therefore show the condition at those times when the hands are as nearly normal as they ever are. During the anemic spasm the loss of sensation is much greater. The hands were then plunged into cold water and the resulting anemia noted.

CASE HISTORIES.

CASE NO. 1, AGE 40 YEARS.

(Examined Jan. 18, 1918.)

HISTORY.

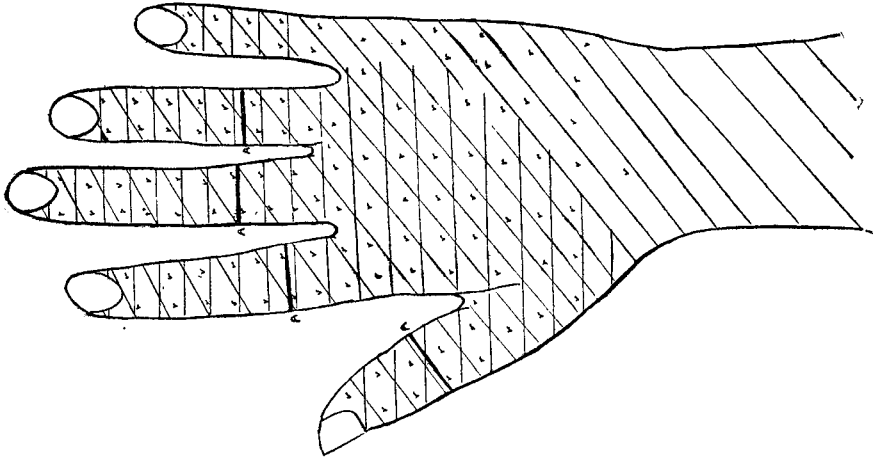
Present complaint.—Dead feeling in fingers. Tingling in the fingers.

Onset and course.—Ever since the patient was 15 years old he has been in the stonecutting trade. Previous to the last 7 years he always used the old-fashioned method of stonecutting, but during the last 7 years he has used a pneumatic stonecutter. He holds the tool with the left hand, and holds the hammer between the thumb and the forefinger of the right hand. The complaints mentioned above are never noticed in the summer unless the weather is cold, but in the winter time the condition is very marked. Even in the morning when the patient gets out of bed to shake the stoves in cold weather his fingers on both left and right hands get white, numb and cold. As long as he is out in the cold his hands are in this condition, but if he keeps them warm they feel comfortable. He generally warms his hands very carefully before he leaves home in the morning and puts on thick gloves to keep them warm. But when he uses the tool at work it seems that the vibration of the machine "drives out all the blood from the fingers" and causes them to become white and cold. When he drops the tool and goes to warm his hands the fingers become red and tingle. If he gets out in the cold air or puts his hands in the snow they become white and "dead." The colder it is the more "dead" they become. If he strokes the fingers from above, below or vice versa the skin gets white instead of red. This condition (the whiteness) lasts for a considerable while.

Present condition.—When the numbness in the fingers first started only the very tips of the fingers were involved, but as the condition gradually became more pronounced it involved all the fingers of the hands with the exception of the right little finger. He thinks the condition is gradually spreading. Anything he grips for some length of time causes the fingers to become white and "dead." When the fingers are white and cold he can not at times distinguish the coins in his pocket. His hands always look bluish red.

Past history.—Measles, when young. No typhoid, scarlet fever, or other diseases of contagion. No frequent sore throats or colds. Has varicocele (enlargement of scrotal and spermatic veins). No operations. No accidents, jars, or injuries.

Family history.—Father dead, 74 years of age, cause unknown. Mother dead, 71 years of age, asthma. No brothers. One sister, liv-



KEY:

Horizontal lines - decrease in sense of touch

Diagonal lines - decrease in sense of pain

V-shaped marks - decrease in sense of heat and cold

A-margin of anemic area after immersion in cold water

The closer the lines the more pronounced the loss of sensation

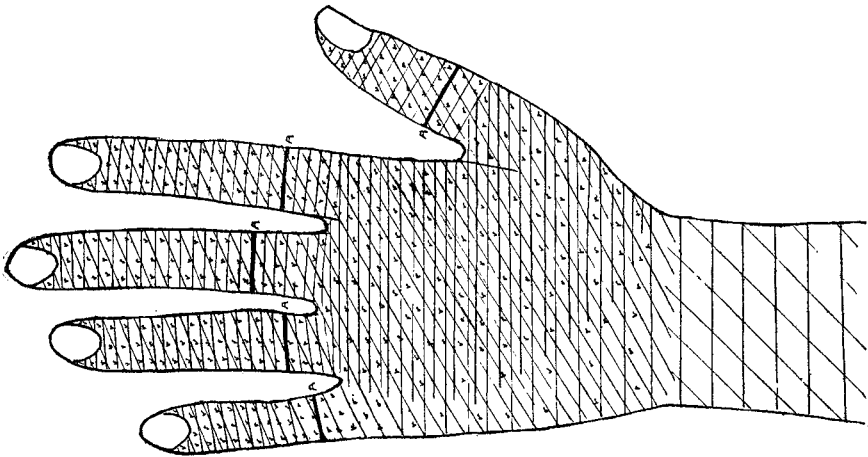


FIG. 1 - HANDS of CASE No. 1

ing and well. Wife's father died of consumption. No cancer, no insanity, no strokes.

Marital history.—Married 20 years; six children living, two dead (one at 1 month, another at 17 months), two miscarriages brought on by work. Wife subject to stomach trouble. No stillbirths.

Venereal history.—Denied.

Habits.—Tobacco—Chews all day; smokes six to twelve pipefuls a day, and cigars occasionally. Alcohol—Moderately only at times; no whisky. Coffee—Scarcely any. Appetite good.

GENERAL FEATURES.

Head.—No disturbances. No aches. No eyestrain or tiredness. No visual disturbances. Teeth very bad; all ulcerated and only roots remain of the most of them. No sore throats.

Chest.—Lungs and heart—No disturbance.

Gastrointestinal.—No indigestion. Appetite excellent. No nausea or vomiting. Tendency to constipation.

Genito-urinary.—Bowels move every other day. No frequency, pain, or burning on urination. Does not get up at night. No disturbance in flow.

EXAMINATION.

Pupils unequal—Right, 4 millimeters in diameter; left, 3 millimeters. Both pupils react to light and accommodation.

Pinching of skin in neck gives some, but not very great, dilatation of the pupils.

Patellar reflexes (knee jerk) present. Oppenheim's reflex present on right side. Babinski¹ negative on both sides. Abdominal reflex present both sides. Cremasteric² present both sides. The vasomotor reflexes of the skin very marked. Idi muscular reaction³ marked.

Hands.—When hands were kept under the bedcover they were warm and red, but after hands had been on top of bedcover for half an hour they began to become cold and later became bluish and of a dusky red color. The skin of the hands was cold up to the wrist. The hands were made warm by covering them and then the sensation tested.

Sense of touch.—Left hand: Sense of touch is decreased over the whole dorsum of hand and fingers. The decrease is, however, less marked on basal phalanx of little finger and the ulnar⁴ part of dorsum of hand. On the volar (palmar) side the decrease in sen-

¹ Dorsal extension of great toe on tickling of sole of foot.

² Retraction of testicle on same side upon stimulation of skin on front and inner aspect of thigh.

³ Contraction of tired muscle under certain conditions of extraneous stimulus.

⁴ Toward ulna or large bone on inside of forearm.

sation is indistinct. Sense of touch is also decreased on ulnar half of the left forearm. Right hand: Sense of touch is slightly decreased on radial¹ part of dorsum of hand and on dorsum of the fingers. Decrease in sense of touch is slight and less than on left hand.

Sense of pain.—Sense of pain is decreased on dorsal surface of left hand and fingers. On the right hand sense of pain is decreased on dorsum of hand and fingers, but not as much as on corresponding points on left hand. On the dorsal surface of forearms, especially left forearm, pain sensation is not as easily elicited as in a normal man.

Sense of temperature.—Temperature sensation is decreased on hands both dorsal and volar surface, and on all the fingers. The decrease is very slight on right hand, but more marked on left.

After the hands had been put into cold water for four minutes all the fingers on left hand became white up to the middle of basal phalanx, and all fingers on right hand excepting the little finger also became white, but not as white as fingers on left hand. The palm and dorsum of hand is pale but bluish on left hand, while the corresponding parts on right hand are more of a bluish red.

In pointing tests the right hand is accurate but left hand is not quite accurate, a slight decrease of sensation of position existing in left arm.

Left arm—circumference, 26.5 centimeters.

Right arm—circumference, 27 centimeters.

No marked perspiration on palms of hands. Skin is soft and thin on dorsal surface of fingers and hands.

CASE NO. 2, AGE 26 YEARS.

(Examined January 18, 1918.)

HISTORY.

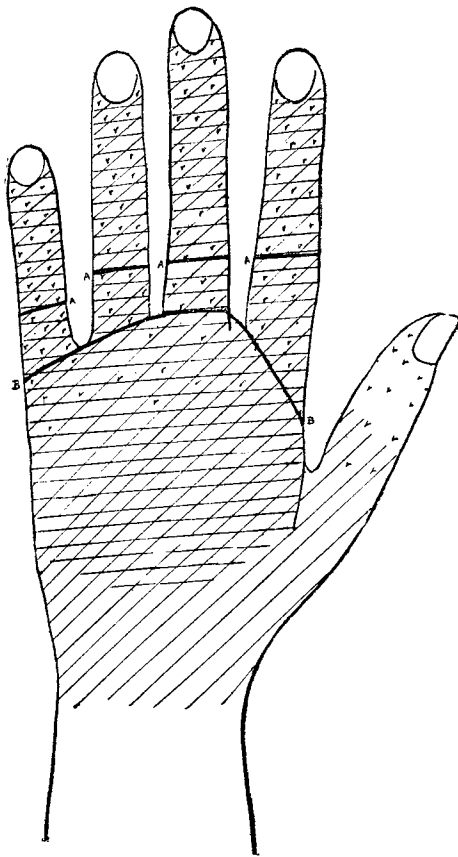
In January, 1918, he had worked as a stonecutter for 14 years, working with the air hammer $3\frac{1}{2}$ years. Fingers on left hand become white and numb when weather is cold. Index, middle, ring, and little fingers show this condition. During work his fingers at times become numb and white, but not always. Fingers on right hand do not become white.

EXAMINATION.

Pupils equally react to light and accommodation and pain.

All reflexes are present and normal.

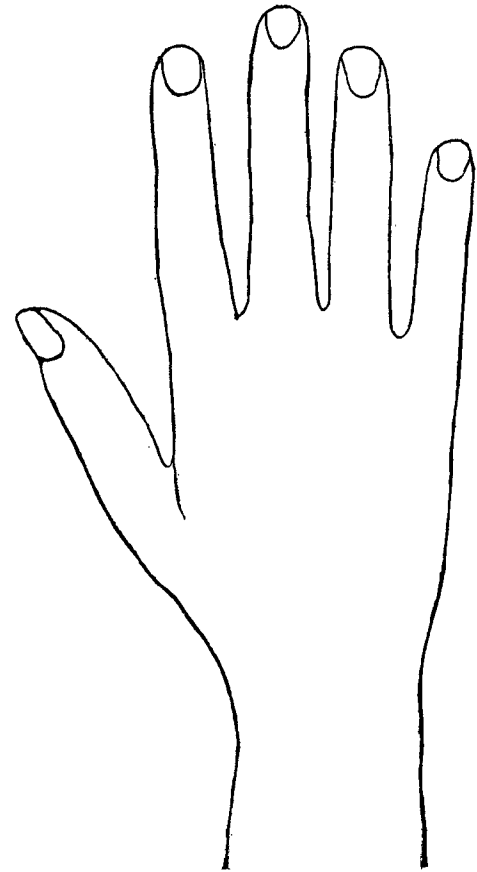
¹ Toward thumb side of forearm.



KEY

- Horizontal lines = decrease in sense of touch
- Diagonal lines = decrease in sense of pain
- V-shaped marks = decrease in sense of heat and cold
- A = margin of anemic area after immersion in cold water
- B = margin of whitish-blue area
- The closer the lines the more pronounced the decrease in sensation

FIG. 2. — HANDS OF CASE No. 2



Tremor in both hands and in tongue.

Vasomotor reflexes of skin somewhat increased.

Teeth in good condition.

Right forearm 27.5 centimeters in circumference; left 26.5 centimeters.

Hands.—On the day of the first examination, although case No. 2 had been in bed for several hours, his hands were cold. The fingers of left hand, except thumb, were distinctly pale and somewhat bluish, and skin over the metacarpophalangeal joints (toward palm) was whitish. Hands as a whole were bluish red.

The second examination on the following day was also given with Case No. 2 in bed. His fingers and palms of hands were cold but skin on dorsal surface of hands was warm. After his hands had been warmed there was a marked moisture on palms of hands.

Sense of touch is decreased on fingers and dorsal surface of left hand.

Sense of pain is also decreased on fingers, dorsum and palm of left hand.

Sense of temperature is distinctly decreased on fingers of left hand; 18° C. and 37° C. are not distinguished with certainty. Sensation on right hand does not present any marked decrease.

After hands had been put into cold water for one minute they were dried. The fingers on left hand are distinctly pale (see fig. 2) and remain so, while the rest of the left hand and whole right hand are purple in color. The whiteness of the fingers is not so marked in this man as in the other cases.

CASE NO. 3, AGE 45 YEARS.

(Examined Feb. 1, 1918.)

HISTORY.

Present complaint.—Turning white of the hands when cold. Numbness of the fingers when cold.

Onset and course.—Has been a stonecutter for nearly 26 years. Twelve years ago he started to use a pneumatic stonecutter and has worked with it on an average of seven hours a day. He holds the hammer in the right hand and the tool in the left, and there is a constant vibration of the tool and the hammer. This affects the left hand most. About 75 to 80 pounds of compressed air are behind this hammer. The first three years he used it for only about half of the shift; the next four years he did not use it at all; but for the last four years he has used it all the time. During the four-year interval his hands appeared to be normal. They did not get cold or numb.

When he first started to use the hammer his hands would swell but did not get white or numb, but when he had used the hammer for a year or a year and a half they began to get white and numb. The whiteness and numbness come on only in cold weather. The little and ring fingers of the left hand were the first parts to show the symptoms mentioned. At first only the distal¹ portion of the fingers were affected by the whiteness and numbness. Then these symptoms gradually extended upward and also involved the middle and index fingers, till now the four fingers are affected up to just above the second joint. The thumb is not affected as much as the other fingers. The right hand is less involved than the left and does not get white, but cold and numb. The left hand began to get cold and white and numb earlier than the right. He does not notice any disturbance in warm weather, but as soon as the cold of the winter sets in the symptoms come on. The hands do not get white and numb in the house, but when he steps outdoors in the cold the hands get as mentioned. He has to thaw them out before going to work with the tool.

Present condition.—Now the condition is more marked in fingers of left hand up to past the second joint. The left hand is always cold and becomes whitish and numb in cold weather. The right hand becomes only cold and numb.

Past history.—Measles, chicken pox, and mumps when a child. Bronchitis at about 39 years of age. No operations; no injuries; no convulsions; and no other nervous disturbance.

Family history.—Father dead, 69 years, quick consumption. Mother dead, 75 years, heart trouble. Brothers, three living, well and strong, and one dead, fractured skull. Sisters, four, all living and well. No tuberculosis or cancer, insanity or nervous disturbances.

Marital history.—Married 15 years; wife well; three children, all well. None dead, no stillbirths. One miscarriage at three months brought on by overwork.

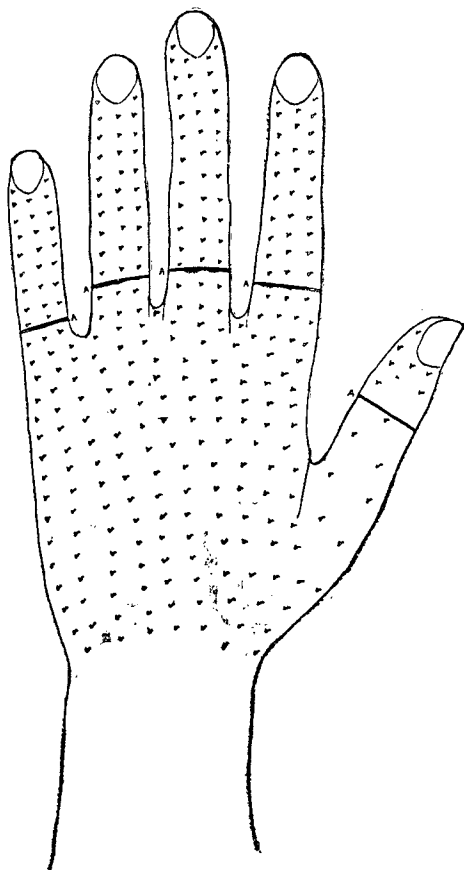
Venerical history.—No gonorrhoea or luetic infection.

Habits.—Tobacco—Smokes five to six cigars a week, no pipe or cigarettes; chews 5 cents' worth a day. Alcohol—None. Coffee—Hardly two cups a day. Tea—Occasionally. Appetite excellent.

GENERAL FEATURES.

Head (physical examination Feb. 3, 1918).—Wears glasses all the time. Vision normal. Pupils normal, react normally. Hearing is very good. No tinnitus (ringing) or noises. No frequent sore throats or colds. Teeth in good condition.

¹ At greatest distance from body.



Key

V-shaped marks = decrease in sense of heat and cold

A = margin of anemic area after immersion in cold water

The closer the lines the more pronounced the decrease in sensation

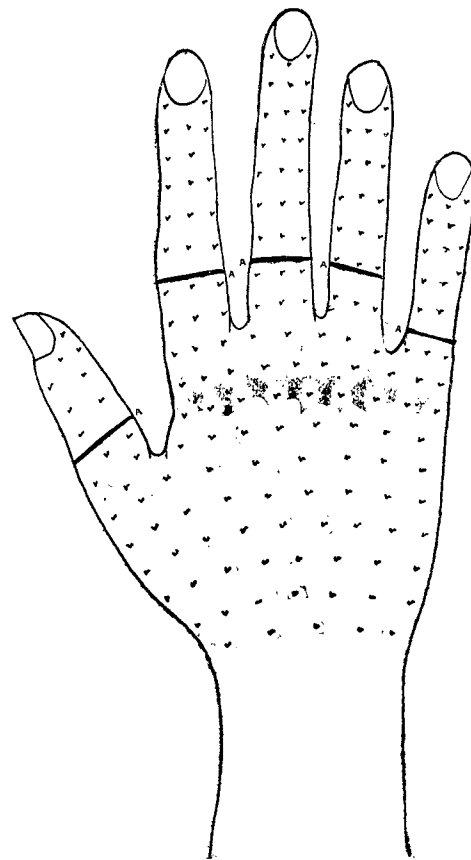


FIG. 3 - HANDS OF CASE No. 3

Thorax.—No symptoms referable to heart or lung disturbances.

Gastrointestinal.—No indigestion, vomiting, nausea, or headaches. Bowels move normally every day.

Urinary.—No frequency at night; no burning or pain on urination.

EXAMINATION.

Reflexes.—All tendon reflexes and skin reflexes present and normal.

Hands.—The idiomuscular reaction very marked. Palms moist. The little fingers become the whitest.

The skin on all the fingers and volar and dorsal surface of both hands is cold. When he stretches out the fingers the skin becomes whitish on the dorsal surface around the joints of the basal and middle phalanx, while the skin on the middle portion of the phalanges and the dorsum of the hand is bluish. The little fingers show the most marked whiteness. On the volar surface of the fingers and in palms the skin is bluish red. When he relaxes the fingers this whiteness disappears. Massaging of the hands produces slight whitening, which disappears only slowly. Skin temperature on both hands 22° C.

Sense of touch.—Normal.

Sense of pain.—No marked disturbance.

Sense of temperature.—Temperature of 39° C. and 30° C. he can not distinguish with either hand with certainty even when grasping the tube tightly. Neither can he distinguish between 35° C. and 24° C. Once in a while after long exposure he will say 35 is the warmest, but just as frequently he will say 24 is just as warm. 18° C. gives him the sensation of coldness, but no temperature above this degree is felt as cold on the hands. The right hand will feel the cold sensation more quickly than the left. Temperature of 34° C. and above will seem a little warmer on the right hand than on the left. Above the wrist, sensation to temperature is normal.

After he has had his hands in snow a little while the fingers of left hand get perfectly white in the two extreme phalanges, but the thumb only on the end phalanx. The skin on the basal phalanges is white on its distal portion but becomes of a more reddish tint toward the phalangometacarpal joints. The skin over the metacarpus is bright red.

On the right hand the skin becomes red over the distal two phalanges; same red tint as on the left side. This bright red color gradually disappears on the left hand in the course of two minutes and the skin takes on the same shade as the dorsum of the hand. After five minutes the skin over the two extreme phalanges of left index finger becomes dark blue on the dorsal aspect but remains

pale at the same time, i. e., the skin seems partly pale and partly pale bluish color.

Left forearm, 26.5 centimeters in circumference; right, 27 centimeters in circumference.

When visited in the hospital where Case No. 3 spent all of one day and part of the next, his fingers on both hands were cold and the fingers of both hands were pale and partly bluish. Upon putting the middle finger of the left hand into cold water for two minutes, all of the fingers on left hand became whitish and cold, the middle finger the coldest. After eight minutes all fingers on left hand were redder than the fingers on the right hand, and were cold.

When in bed and keeping his hands under the bedcover his hands would be warm and moist, but after they had been placed on top of the cover for a short while their temperature would become lowered and fingers become pale. Any testing of the pain sensation would increase the paleness.

CASE NO. 4, AGE 28 YEARS.

(Examined Feb. 11, 1918.)

HISTORY.

Present complaint.—Numbness, coldness, whiteness, painfulness, and tingling in the hands and fingers when the weather is cold. Swelling of the left hand and fingers all the year round. Weakness of fingers and hands when numb.

Onset and course.—The patient has been in the trade since 1909. He worked for two years with the air hammer, after which he used the mallet for two years. Then he went back to the air hammer and has used the hammer ever since. After about two and one-half years, patient noticed a whiteness, numbness, and coldness in the left ring finger coming on during work, especially on cold days. The ring finger he uses to support the tool with. The whiteness in this finger was always more extensive than in the other fingers. Then the condition progressed slowly and soon all the terminal phalanges of the left hand with which he used the tool were involved. During the following winter the numbness began to affect also the middle phalanges of the fingers. About 1915 he noticed a numbness in his right index finger and it was only about last June that he noticed on a cold day a distinct whiteness of the other fingers of this hand. The index finger is the most affected on the right hand while the little and ring fingers are practically free from numbness. The hammer is held between the index and middle fingers. The fingers become white up to the metacarpophalangeal joints.

This left arm gets sleepy very readily and feels numb when he lies down in bed.

At times when the hands are recovering from coldness and numbness they become so painful he can "hardly stand it." The numbness and whiteness of fingers come on in same way and seem to be influenced by the same conditions as in the other men.

Past history.—Measles, when a child. Always strong and healthy. No operations. No injuries.

Family history.—Father dead, 40 years of age, broken ribs. Mother dead, 49 years of age, cancer of stomach. Brothers, two dead, one living and well. Oldest died of tuberculosis. Sisters, one living, one dead. Pneumonia caused death. No tuberculosis, cancer, insanity, or nervous disturbance.

Marital history.—Married five years; two children, one dead, miscarriage at seven months. No stillbirths. Wife well. Children strong. Divorced and remarried.

Veneral history.—Gonorrhoea, twice; mild attacks. Chancre, two years ago. Treated with 606 twice, two years of mercury treatment.

Habits.—Alcohol—never to excess. Tobacco—One package of cigarettes a day. Chews moderately; 10-cent plug a week. Coffee—one cup a day. Tea—one cup a day. Appetite excellent.

GENERAL FEATURES.

Head.—Was once hit in left eye with a piece of stone. Left eye weak. Vision poorer in left eye than in right. No headaches. Slight dizziness. Toothaches. No sore throats now but had some during syphilis. No loss of hair.

Lungs.—No symptoms.

Heart.—Normal.

Gastrointestinal.—Slight constipation. No indigestion. Heartburn after dinner. No vomiting.

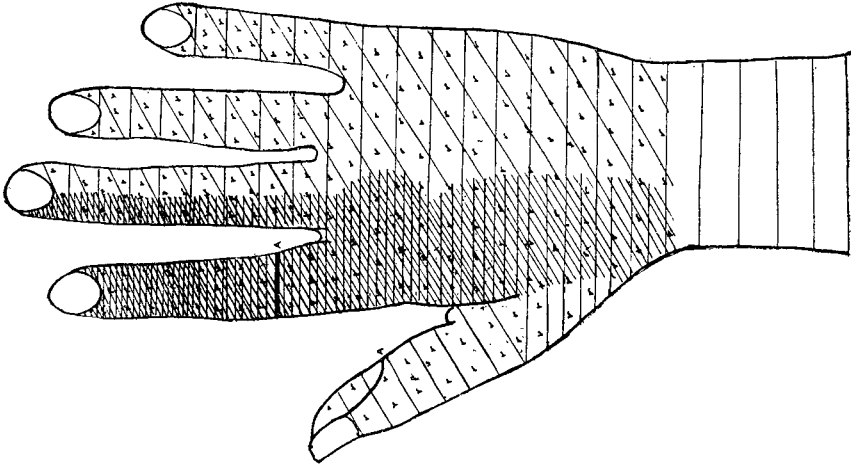
Genito-urinary.—Nothing abnormal.

EXAMINATION.

Pupils equal, react to light and accommodation, but left pupil reacts sluggishly. Hearing is decreased in right ear. Hears watch 10 centimeters away from ear. No paralysis in any part of the body. Abdominal reflexes lively. Cremasteric reflexes lively. Patellar reflex present but rather hard to get. Achilles tendon reflex¹ present. No Babinski reflex. Plantar reflex² lively. Vascular reflexes lively and long lasting. Idi muscular reaction present.

¹ Contraction of muscle of calf of leg on tapping of the cord at back of heel.

² Contraction of toes on irritation of sole of foot.



KEY

Horizontal lines = decrease in sense of touch

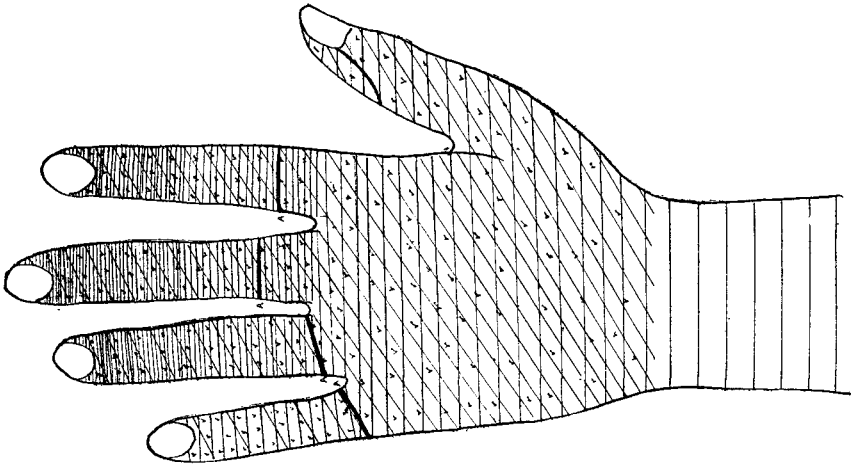
Diagonal lines = decrease in sense of pain

V-shaped marks = decrease in sense of heat and cold

A = margin of anemic area after immersion in cold water

The closer the lines the more pronounced the decrease in sensation

Fig. 4. HANDS of CASE No. 4



Sense of touch.—Hands were made warm before sensation was tested. Skin not thickened on dorsal surface, excepting on right middle finger (see fig. 4). The sensation to touch is decreased on both hands, and does not seem quite normal on the forearms. On the forearms a heavier stroke by cotton has to be used than in a normal man to give sensation. Above elbows on both sides sensation to touch is normal. Sensation to touch is not equally decreased on all parts of hand but is decreased on both dorsal and palmar surfaces. The decrease is more marked on index fingers of hands and least marked on the little fingers and thumb. On the right hand sensation is markedly decreased on index finger, radial half of middle finger, and radial part of hand (see fig. 4).

Sense of pain.—He is very uncertain in distinguishing between sharp and dull on fingers and dorsal surface of left hand and pin pricks on penetrating the skin are not felt as pain and only occasionally as sharp.

On little finger, sensation to pain is less decreased than on other parts of hands. On palm of hand sensation to pain is less decreased.

On the right hand sensation to pain is also decreased on all fingers and dorsum of hand. He is unable to distinguish between dull and sharp on index finger, radial half of middle finger and radial part of hand (see fig. 4). On the other fingers and on ulnar part of hand sensation to pain is much less decreased. On dorsal surface of forearms sensation to pain is also somewhat decreased.

Sense of temperature is decreased on both hands. He can distinguish on all parts of hands between temperature of 43° C. and 20° C., but stimulus has to remain longer on skin than normally in order to be recognized. He is, however, unable to distinguish with any certainty between temperatures of 29° C. and 34° C. on either hand, no matter how long stimulus remains in contact with skin.

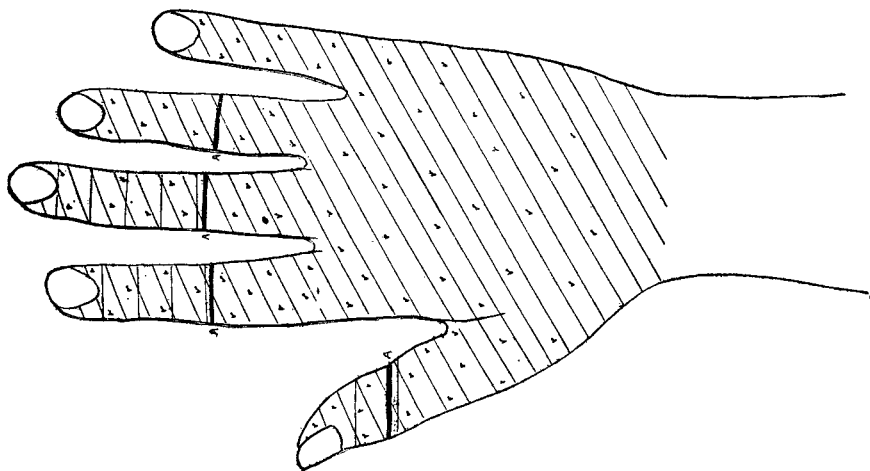
During the testing of the sensation his hands became cold and had to be warmed again by patient putting them under the bedcover. After hands had been placed in cold water, the fingers became whitish (see fig. 4) and rest of hands reddish blue. When hands had become warm again there was a marked perspiration in palms of hands.

CASE NO. 5, AGE 24 YEARS.

(Examined Feb. 13. 1918.)

HISTORY.

Present complaint.—Whiteness, numbness, coldness of hands and fingers in cold, damp, or chilly weather. Pain in fingers when blood comes back. Tingling of fingers when cold. Swelling of fingers



KEY

Horizontal lines = decrease in sense of touch

Diagonal lines = decrease in sense of pain

V-shaped marks = decrease in sense of heat and cold

A = margin of anemic area after immersion in cold water

The closer the lines the more pronounced the decrease in sensation

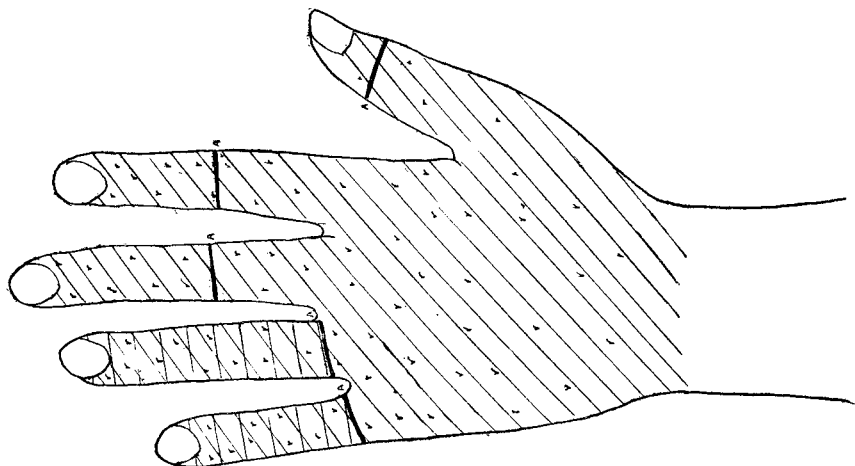


FIG. 5.—HANDS OF CASE No. 5.

when cold. Awkwardness, clumsiness, and inability to feel, or to perform precise movements when hands are cold. Pain in the left shoulder lately.

Onset and course.—Has been in trade approximately eight years and has always used the pneumatic tube an average of six hours a day. Trouble first began in the right hand about two years after he started to use hammer. It first started by terminal phalanges becoming white in chilly or cold weather and then progressed until now the symptoms which he complains of affect four fingers past the second finger joints. The thumb is only affected in a small region on the tip, where there is the same trouble. He soon afterwards noticed the condition in the left hand, beginning in the little and ring fingers and gradually involving these fingers up to the metacarpal joints. The middle and index fingers are now also involved up to above the second phalanx. The thumb is involved only a little, just enough to say it is beginning. The little, ring, and index fingers of left hand are affected more than the other fingers. He notices numbness and a dead feeling and is unable to feel things and to do precise movements when fingers are white. His fingers swell and throb when the blood comes back to the fingers. There is throbbing of pulse with pain and tingling and it feels as if the ends of the fingers would burst open. He notices after hands have "been dead and are beginning to come back" a white and red mottling of skin, especially on his palm. His hands get numb in the morning and then again at noon, and about 3 or 4 in afternoon. It seems that his hands get numb and cold more easily in the afternoon than in the forenoon and sometimes they stay dead three or four hours at a time. His fingers swell. The condition came on slowly and is progressing gradually.

Past history.—Always well as child and young adult. Measles about two years ago. No operations. No sickness other than above complaints.

Family history.—Father living and well, 59 years of age. Mother living and well, 54 years of age. Brothers, three living, none dead. No sisters. No insanity, tuberculosis, cancer, strokes, or nervous disturbances.

Marital history.—Married four years, no children living. Two born dead, full term. One breech presentation; other cord around neck. No miscarriages. Wife well.

Venereal history.—Gonorrhoea and syphilis—Denied.

Habits.—Tobacco—Two cans a week. Alcohol—Seldom. Coffee—Two cups a day. Appetite good.

GENERAL FEATURES.

Negative.

EXAMINATION.

Head.—Scalp, negative. Eyes react to light and accommodations. No hemianopsia,¹ strabismus,² nystagmus.³ Pupils round and regular. Mouth—No large tonsils; teeth fair; tongue protrudes straight. No cranial nerve palsies.

Neck.—Negative. No adenopathy⁴ anywhere.

Chest.—Negative.

Abdomen.—Negative.

Reflexes.—Wrist, elbow, knee, ankle, plantar, abdominal, and cremasteric reflexes present. Right and left equal. Babinski negative.

Coordination.—No gross disturbances.

Sensation.—Lower extremities and trunk negative. (See statement as to hands, below.) Feet moist and clammy.

He presents markedly the symptoms of dermatographia⁵ with formation of urticaria factitia⁶ on the skin.

Idiomuscular reaction is very marked in all muscles.

Hairs are very few on dorsum of hands.

Sense of touch.—When hands are warm there is only a very slight decrease of sensation to touch on dorsum of the fingers of both hands. When hands are cold the sensation is much decreased, but not equally so on all parts. The decrease is most marked on little and ring fingers of left hand and index, thumb, and long finger of right hand.

Sense of pain.—Pain sense is decreased on dorsal surface of fingers and dorsum of hand, both on left and right hand. It is also decreased on dorsal surface of right forearm.

Sense of temperature.—Temperature sense decreased on hands and fingers.

Hands were kept warm during examination.

When hands were put in cold water, and then dried, fingers showed whiteness. (See fig. 5.)

CASE NO. 6, AGE 38 YEARS.

(Examined Feb. 6, 1918.)

HISTORY.

Present complaint.—Weakness in the fingers. Coldness in the hands. Whiteness of the fingers when cold; otherwise whitish

¹ Blindness in half the visual field.

² Abnormality of eyes in which visual axes do not meet at desired objective point.

³ Oscillatory movement of eyeballs.

⁴ Any disease of gland or glands.

⁵ Condition of skin in which words or marks made on skin leave more or less persistent traces.

⁶ White or pinkish ridges.

patches over the fingers. Numbness and dead feeling in the hands and fingers when cold. Sleepy feeling in the arms in the early morning. Rheumatoid pains in hands and muscles of arms.

Onset and course.—The patient has been in the stonemasonry trade for 20 years, and has used an air hammer for 13 years, with the exception of 1½ years when he worked as a barber. He has used the pneumatic stonemason on an average of 6 to 7 hours a day. About 1½ years after he started to use the air tube, which has about 70 to 75 pounds of compressed air back of it, he noticed the tip of his right index finger getting white, especially in weather which was damp and cold, and even on cooler days during the summer.

Gradually the whiteness involved more and more of the index when he worked under the named conditions and even the other fingers became involved until the whiteness when present would take in all the fingers of right hand. Later the whiteness involved left hand, beginning in the same manner and involving the same parts as on the right hand. This whiteness and coldness has been accompanied by numbness and a dead feeling and on occasions his hands tingled and pricked so that it almost made him cry. This occurred as it seemed when blood would rush back to the fingers, after exposure to cold weather.

Cold water caused the whiteness to appear. In the summer he has noticed a swelling of the fingers. This swelling comes on mostly in the morning, after washing, and makes it difficult for the patient to shut his hands.

Just lately he has noticed that his fingers are not as strong as they formerly were and when he tries to grasp things his fingers give way.

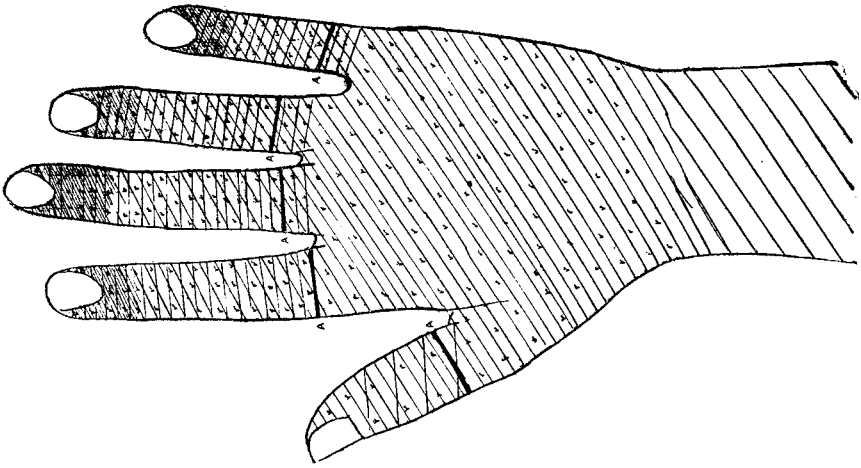
In the morning before getting up, his arms feel dead and weak. However, he rubs them and finally they feel better. He notices the same thing in the night after returning from work. His arms appear to go to sleep and he feels a creeping movement in the ends of the fingers. They seem to "wake up."

During work he has to shake his hands to get the blood down. If he washes his hands in cold water they get white. When he is in the house by the fire he does not notice the whiteness or numbness, but the hands feel weak.

When he leaves his home in the morning the minute the cold air strikes him his fingers get white, cold, and numb. When he throws his hands down violently the rush of the blood to the end of the fingers produces a tingling, creeping feeling.

Present condition.—The condition has been getting worse and now he notices also the weakness mentioned above.

Past history.—No childhood diseases. Frequent colds. Occasional tonsillitis. No operations. No severe injuries.



Key

Horizontal lines = decrease in sense of touch

Diagonal lines = decrease in sense of pain

V-shaped marks = decrease in sense of heat and cold

A = margin of anemic area after immersion in cold water

B = Margin of whitish-blue area

The closer the lines the more pronounced the decrease in sensation

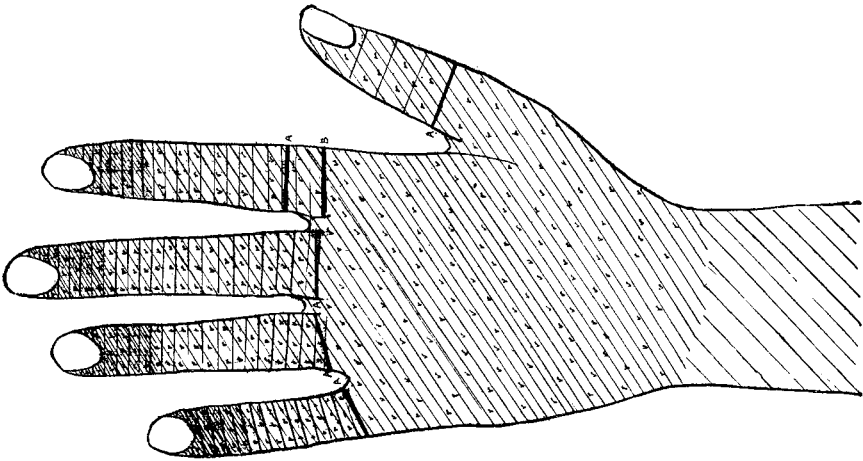


FIG. 6 — HANDS OF CASE No. 6

Family history.—Father living and well, 65 years. Mother living and well, 63 years. Brothers, two living and well, one died at one year of age. Family always healthy and live to old age. No tuberculosis, cancer, insanity or nervous disturbances in family.

Marital history.—Married 12 years. Five children living, five children dead: One at 11 months, of pneumonia; one at 43 days; twins at 7 months, of indigestion; another at 1 month, cause unknown. One miscarriage at two to three months. No stillbirths. Wife quite healthy.

Venereal history.—Denied.

Habits.—Tobacco—Chews occasionally, smokes four to five cigarettes a day, no pipe or cigars. Coffee—One cup a day. Tea—Occasionally. Appetite—Excellent. Bowels—Fairly regular.

GENERAL FEATURES.

No symptoms referable to disturbances in other organs.

EXAMINATION.

The examination was made in room temperature. Hands and fingers warm, with exception of fingers on left hand. Palms not moist. Color of skin dusky red and bluish up to wrists, beyond which it is of practically normal color. The left hand differs from the right, the fingers being pale and cold up to above the second phalanx. The right is more bluish red than left. When he shuts his hands and squeezes them tightly together for a moment the palms of the hands and the palmar sides of the fingers remain white and bloodless, blood not returning to skin as in a normal hand. This condition is more marked in left than right hand. Stroking the skin on backs of hands produces a whitish coloration which spreads and remains for a couple of minutes.

Sense of touch.—There is slight decrease of sensation of touch on the fingers of both hands, more marked on the end phalanges.

Sense of pain.—Sensation to pain is greatly reduced on both hands. Hard pressure with a pin point is felt only as a pressure, and only occasionally as pain on dorsum of hands and fingers, and even penetrating pricks are only at times felt as pain. On the palmar surface of hands and fingers the sensation of pain is also much decreased, but not so much as on the dorsal side. The decrease in sense of pain is most marked on the end phalanges of the fingers and gradually becomes less toward the wrist. On the forearm the sensation to pain is about normal on the volar side, but distinctly decreased on the dorsal side up to the elbow. The decrease in sensation to pain is, however, less marked on the dorsum of forearm than it is on the dorsum of the hand.

Sense of temperature.—Sensation to temperature is also decreased on both hands. He can distinguish between temperature of 37° C. and 24° C., but test tubes have to be left much longer in contact with skin than is necessary in a normal man, and even at temperature of 40° C. he does not feel always as warm if the contact has not been prolonged for four to five seconds.

During the testing of the pain sensation the fingers on both hands become pale and cold, the pricks with the pin evidently causing a marked vasoconstriction, instead of, as normally, a vasodilatation.

The hands were put into cold water for three minutes, and then dried. The fingers were now white up to a little past the middle of the basal phalanx. In the region of the phalangometacarpal joints the skin was of a bright red color and shaded off from red to bluish red up to the wrist. The skin on the wrist and above had normal color. Both hands were practically alike in color, but the changes were slightly more marked on the left hand. After eight minutes the hands began to change to a more normal color, but even after 15 minutes some whiteness still remained in the fingers.

The hands and fingers were rubbed and after the blood circulation seemed more normal were left to rest for several hours. After this period of rest the muscles of the hands were tested with the galvanic current. The reactions were normal, but during the application of the galvanic current to the hands, the fingers on both hands became cold and whitish. A few minutes after the galvanic current had been stopped the fingers became warm and red, and also showed marked perspiration.

Pupils reacted normally, and were of normal size.

Tendon reflexes in arms normal. Achilles tendon reflexes normal. Foot sole reflexes, cremasteric reflexes, and abdominal reflexes normal. No Romberg symptoms,¹ no ataxia, no enlargement of lymph glands.

On the dorsum of the hands the hairs are unusually few, but the hairs are also sparse on his legs.

CASE NO. 7, AGE 24 YEARS.

(Examined Feb. 13, 1918.)

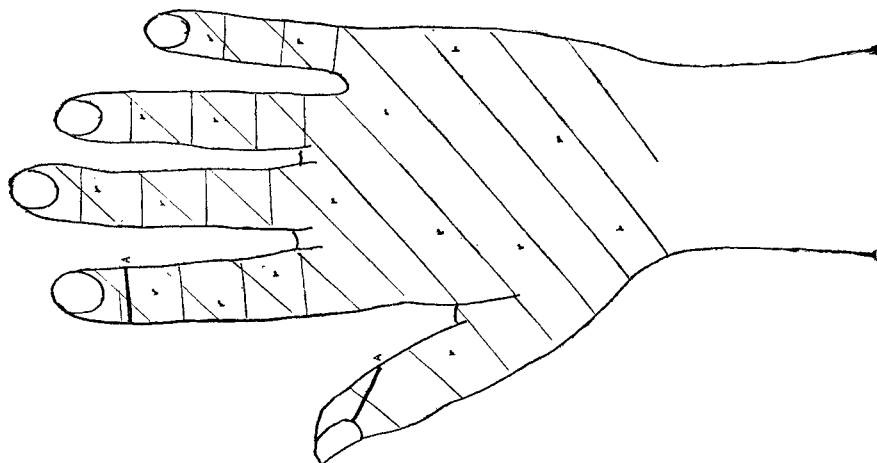
HISTORY.

Present complaint.—Coldness of hands and fingers in damp, chilly, and cold weather. Aching pain in the right shoulder and upper arm; whiteness of the hands and fingers in cold, chilly, or damp weather. Numbness and tingling, "dead feelings," in fingers. Pain when blood returns to fingers after whiteness.

¹ Increased incoordination of movement, in locomotor ataxia, caused by placing the feet in juxtaposition and closing the eyes.

Onset and course.—The patient has been a stonecutter for eight years, and has used the pneumatic cutter on an average of seven hours a day for eight years. He holds the hammer in various ways, but usually with the thumb and first three fingers. Occasionally he rests the little finger of the right hand on the tool. He grips the tool with all fingers of the left hand. The thumb of the left hand is not used much in holding the tool, but the thumb of the right hand is used much.

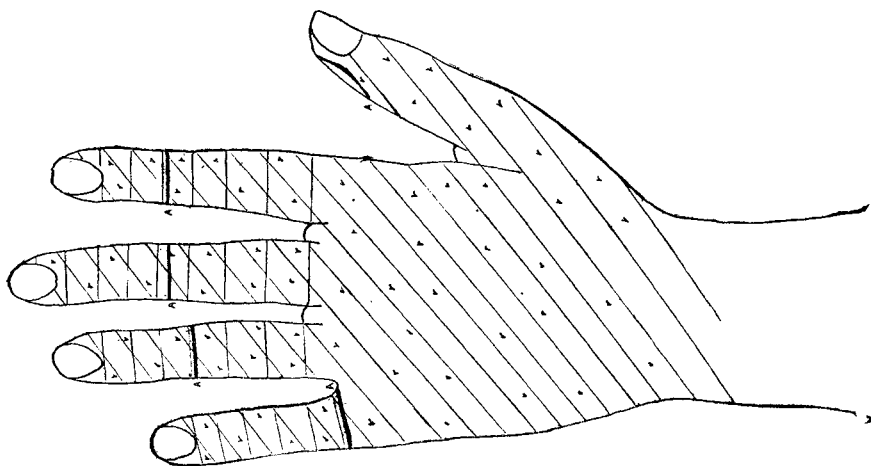
After he had been working with the pneumatic cutter for two years he noticed on days when weather was damp and chilly or cold that during the work he would get a feeling of numbness in the little finger on the left hand and this finger would become white and cold. At first only the terminal phalanx was affected, but gradually the whiteness and numbness, when present, extended up to the metacarpophalangeal joint. Later the ring finger and still later the middle finger became affected in the same way as the little finger, the symptoms first appearing in the ends of the fingers and then gradually spreading upward until now the middle and end phalanges of these two fingers are affected. Of the index finger only the extreme phalanx is affected by the whiteness and numbness, while the thumb is hardly involved at all. Lately the right thumb and forefinger show some symptoms in the terminal phalanx. They do not actually become white, but have a "dead numb" cold feeling. The middle, ring, and little fingers on right hand have escaped thus far. The condition seems to him to be progressing. Sometimes it appears as "though the fingers become swollen." Some mornings before the kitchen fire is made the left hand will get numb, white, cold, and "dead." He swings his arm and throws it forward, repeating this movement until hand gets warm. He feels the blood "rush toward the hands" when he swings his arm. The pulse starts to throb and then the hands begin to tingle and ache. If he tries to warm the hands before the fire the pain is more severe. The hands feel clumsy and it is hard to do things when they are cold. It is difficult to feel, and control is lost when the hands are cold. He has noticed no distinct weakness. When going to work the fingers get cold and especially when they grip things, like the lunch basket, etc. He always warms up his hands before starting work. The hands seem to become white and cold more easily right after dinner. Coming home from work in the evening his hands are bad. He sometimes gets a pan of cold water to keep his hands from warming up too quickly. Thus he avoids pain. The right arm aches during the night at times and wakes him. When he goes away from work for a time, a month or so, and then comes back, the back of his hand will ache and feel peculiar from the vibration of the instrument.



KEY

- Horizontal lines = decrease in sense of touch
 - Diagonal lines = decrease in sense of pain
 - V-shaped marks = decrease in sense of heat and cold
 - A = margin of anemic area after immersion in cold water
- The closer the lines the more pronounced the decrease in sensation

FIG. 7. HANDS OF CASE No. 7



Past history.—Measles and mumps when a child. Colds in nose, influenza. No operations; no severe accidents.

Family history.—Father living and well, 56 years. Mother living and well, 53 years. Brothers, three living, none dead. Sisters, two living, none dead. No tuberculosis, cancer, insanity, or other nervous condition in family.

Marital history.—Nearly three years. No children. Wife well, not strong. No miscarriages. No pregnancies.

Habits.—Tobacco—Smokes pipe, two cans of tobacco a week. Does not chew. Alcohol—Occasionally. Coffee—Two cups a day. Appetite very good.

GENERAL FEATURES.

Head.—Eyesight good. No headaches. No disturbance in hearing. Teeth good. No sore throats.

Chest.—Lungs—Negative as to symptoms.

Gastrointestinal.—No indigestion, nausea, or vomiting. Bowels regular.

Urinary.—No frequent urination. No burning or pain.

Joints O. K.

EXAMINATION.

Head.—Scalp—Negative. Eyes—Pupils react to light and accommodation. Pupils round, regular but unequal. No nystagmus, strabismus or hemianopsia. Right pupil 5 millimeters; left pupil 4 millimeters. Ears—Hearing a little deficient on right side. Nose—No discharges. Mouth—Tonsils not enlarged. Teeth good. Tongue protrudes straight. No cranial nerve palsies.

Neck.—Negative.

Chest.—Lungs and heart negative.

Abdomen.—Negative.

Reflexes.—Wrist, elbow, knee, ankle, abdominal, cremasteric, plantar present. Right and left equal. The vascular reflex in skin comes slowly. Babinski negative. Indiomuscular reaction very marked in muscles of arms and chest but not so marked in leg muscles.

Hands.—Before hands were tested they had been kept under the bedcover for some time to keep them warm.

Sense of touch is slightly decreased on both dorsal and volar surface of all fingers of left hand except the thumb. Sense of touch on the palm and dorsum of left hand is practically normal. On the right hand the sense of touch does not seem to be quite normal on the fingers, but the decrease, if any, is so slight that it is insignificant. Above the wrist the sense of touch is normal on both arms.

Sense of pain.—Can distinguish between a sharp point and a blunt point with nearly normal accurateness on fingers and hands on both sides, but penetrating wounds are only occasionally felt as pain on dorsum of hands and fingers of both left and right side. Above the wrist the pain sensation is about normal.

When the testing of the sensation of pain and temperature started, both hands were warm, but after the testing had proceeded some time the temperature of skin on hands had become distinctly lowered and his hands had to be put under cover to warm up again. When finally the tests had been finished, the hands were allowed to remain on top of cover. The fingers of left hand became cold and bluish white (thumb and index less than the other fingers). The whole palm of left hand is cold, while the skin on the dorsum is much colder on the ulnar half than on the radial half. The skin on right hand also became cold, but did not show as marked change as skin on the left hand; however, the two extreme phalanges of the fingers became cold, but not distinctly anemic. The thumb on the right hand did not become cold during the test.

Sense of temperature.—He distinguishes quicker and with more accuracy between temperature of 20° C. and 40° C. on the right hand than on the left. He is able to distinguish between temperature between 25° C. and 33° C., but the exposure has to be made longer and the exposed surface has to be larger than in a normal person. The palms of hands showed marked perspiration when warm.

CASE NO. 8, AGE 33 YEARS.

(Examined Feb. 11, 1918.)

HISTORY.

Present complaint.—Hands cold, though only in cold weather. Numbness of hands and fingers. Tingling of hands and fingers. Soreness of elbow after prolonged use of right arm. Weakness and loss of grip of fingers when hands are cold. Swelling of the fingers. Whiteness of the fingers when cold.

Onset and course.—The patient has been in the stonecutting trade 18 years and has been using the air hammer, on an average, 6 hours a day. This is not done every day because some days the mallet is used. Though the patient does not remember absolutely, he thinks his trouble began with whiteness in the fingers of the left hand 10 years ago. It involved the left little finger first. He holds the tool so that much of the weight falls on the little finger. Later all of the fingers, and finally the whole hand, were involved. The whiteness usually extends up to the metacarpophalangeal joint but sometimes goes farther. His right hand never was affected this way until this winter when the symptoms mentioned above occurred all at once

and now symptoms are equally severe in both hands. When affected the hands first get numb and a little later they become white and when color returns in the fingers they are painful and sometimes extremely so. He compares this pain to the feeling which may occur in a normal hand when it begins to get warm after it has been in contact with snow or ice for some time.

The condition has been getting worse and on left side numbness now not only involves the finger but also the ulnar side of wrist and ulnar half of hand. No similar region is noted on the right hand. When the hands get cold they are particularly weak and it is hard to grasp and hold things. They are weak nearly all the time but especially so in cold weather. The trouble seems to come on more readily in the morning. In the summer he does not suffer from these symptoms but there is a certain degree of swelling in fingers and hands.

Past history.—Measles, mumps, chicken pox, whooping cough, all in childhood. Smallpox two or three months ago. Tonsillitis, malaria, three or four years ago. No operations. No severe injuries.

Family history.—Father dead, pneumonia, cancer of face, 65 years of age. Mother dead, congestive chill, when patient was young. Brothers, one living and well, none dead. Sisters, two living and well, none dead. No tuberculosis, no insanity or nervous disturbances. Father had cancer.

Marital history.—Married 13 years. One boy living. None dead. Two miscarriages, at three months and four months. Lacerated perineum from instrumental delivery of boy previously. No stillbirths.

Veneral history.—Gonorrhoea, 8 or 10 years ago. No luetic infection.

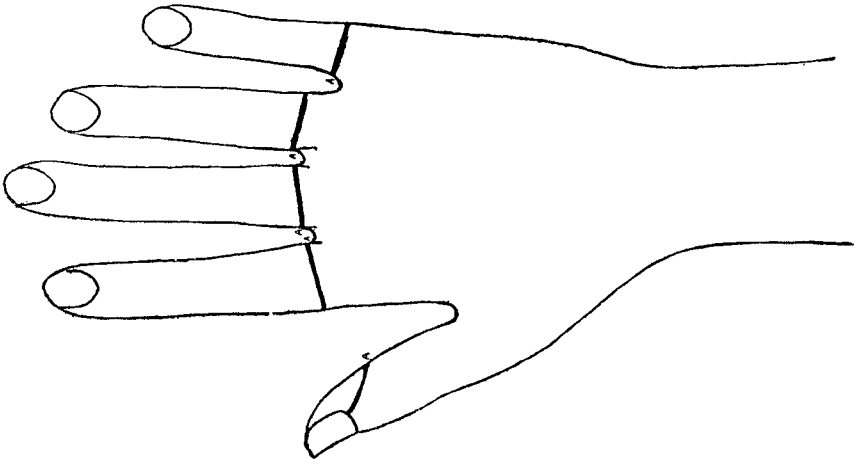
Habits.—Tobacco—Pipe, cigarettes, cigars, about 20 a day; chews a 5-cent plug a day. Alcohol—Never to excess. Coffee, tea, and cocoa—Four or five cups a day. Appetite, fair.

GENERAL FEATURES.

Head.—No headaches, no dizziness. Does not know of disturbance of eyesight. No glasses. No sore throats, but has frequent colds. Hearing is slightly disturbed lately. Continuous ringing in ears. No aching teeth.

Lungs.—Has a cough. No blood. No loss in weight. No fever. Shortness of breath on exertion—short winded. No edema. Pleurisy two years ago.

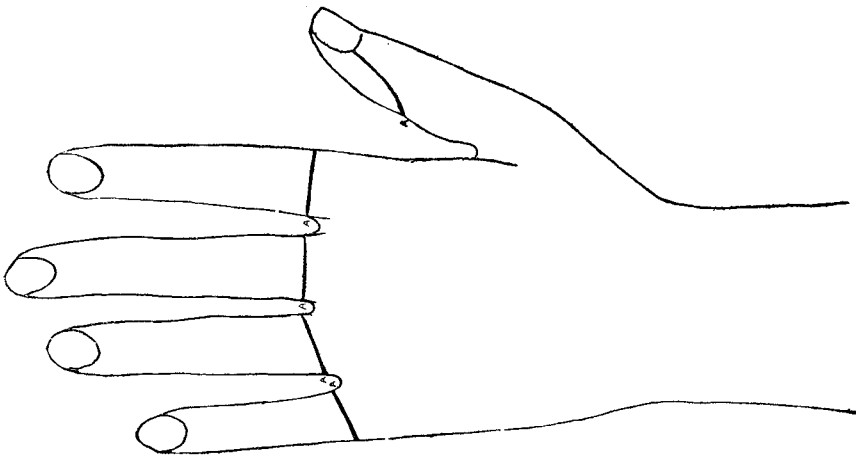
Gastrointestinal.—Constipated. Habit of taking physics about once a week or oftener. Occasional attacks of indigestion which soda relieves. Burning in epigastrium. Dull griping pain, cramp-



KEY

A = margin of anemic area after immersion in cold water

FIG. 8.—HANDS OF CASE NO. 8



like in character. When he gets hungry the pain increases. Eating relieves. This occurs only once in a while.

Genito-urinary.—No nocturnal urination. No burning or smarting.

EXAMINATION.

Head.—Scalp—Negative. Eyes—Pupils equal and round. React to light and accommodation. No nystagmus or strabismus. No ptosis.¹ Nose—No disturbance. Ears—No disturbance. Mouth—Quite good. Tonsils not enlarged.

Neck.—No adenopathy—no pulsating veins. No thyroid enlargement.

Thorax.—Symmetrical. Lungs—Negative. Heart—Negative.

Abdomen.—Negative.

Reflexes.—Abdominal, present and equal; plantar, present, lively; cremasteric, present and equal. Elbow, wrist, ankle, knee, present and equal. No Babinski. Idi muscular reaction very marked.

Coordination.—No gross disturbance. Pupils 5 millimeters wide.

The hands were warm at the time when examination started. The skin on the fingers and in palm of hand was reddish but on the dorsal surface of the hand the skin was of normal color. There did not exist any distinct decrease in sensation of pain, temperature and touch. During the examination, however, the skin on the fingers became colder and the sensation to pain was not so acute as when fingers were warm. The decrease in temperature of the skin occurred although examination was conducted in a warm room.

After examination of sensation was finished hands were exposed to out-of-door temperature for a few minutes. The hands changed markedly in their appearance. The fingers became white or bluish white presenting the typical appearance of anemia spastica, and the hand itself was of a bluish-red color. The sensation to touch, temperature, and pain in the fingers was now much diminished.

¹ Complete or partial drooping of the upper eyelid.

REPORT ON EIGHT CASES AT CAMP SHELBY, MISS.

BY MAJ. N. A. CARY, MEDICAL CORPS.

I have personally investigated the physical condition of eight enlisted men of the One hundred and thirty-ninth Field Artillery who have had from 4 to 14 years' experience in stonemasonry in Bedford, Ind., and other quarries, and the data collected in each individual case are as follows:

No. 1 gives history of stonemasonry of seven years. He has had no experience with the pneumatic hammer. No physical defects were found.

No. 2 has had seven years' experience as stonemason. Three years of this time he used the pneumatic hammer. Case complains of numbness in all fingers, bilateral, with pain in the arms, bilateral. The numbness and tingling is most marked on cold and damp days and after taking shower baths. He complains of being nervous, has a slight insomnia, ringing in the ears, which condition has not improved since entering service. There is a profuse sweating of hands and forearms that he states is present both day and night. He has a slight tremor at present, has gained 10 pounds in weight since entering the service and his appearance is that of a well-nourished man. The numbness complained of does not seem to interfere with movement, and his ability to handle the piece (rifle) is not interfered with. He states that he is unable to restore a normal feeling in the hands and arms by artificial heat, but by calisthenics the feeling is restored in five to six minutes. I personally observed the hands of this man on a cold morning and found that the fingers were markedly cyanosed, the finger nails were quite blue, and by the use of a pin feeling was demonstrated to be absent.

No. 3 has had 12 years' experience as stonemason and 10 years' use of the pneumatic hammer. He complains of dull, dead feeling in fingers and forearm of left hand on cold mornings, also first finger of right hand. Movement of fingers is markedly interfered with on cold mornings. He is unable to button his clothing or to hold shoelaces while at gun drill, but says piece feels cumbersome because he is un-

able to get proper feeling in his fingers. He says heat will not warm fingers and hand, but that it requires movement for six to seven minutes to restore proper feeling. If gloves are placed on the hands while numbness is present the hands remain in this condition for hours without change. He has made no gain in weight since entering service and says there is no improvement in his condition since entering service. He has a hacking cough that he has had for the past 4 years. Physical examination shows cyanosis of fingers in left hand and lower part of left forearm. His finger nails are blue and partial anesthesia is present.

No. 4 has had four years' experience as stonecutter and four years' use of the pneumatic hammer. He complains that on cold mornings the first and second joints of the fingers of the left hand have a peculiar dull, dead feeling. He has never noticed any interference with handling of the piece at gun drill, and gives practically the same history as No. 3 relative to hands remaining dead unless exercised. Physical examination shows cyanosis of proximal phalanx, first and second fingers; left hand shows partial anesthesia present.

No. 5 has had six years' experience as stonecutter, two years' use of pneumatic hammer. He has a slight numbness in little finger of his right hand, which is most marked on cold days. He has no other symptoms. He has gained 10 pounds in weight since entering the service. Physical examination shows slightly cyanosed little finger of right hand, and no anesthesia.

No. 6 has had seven years' experience as a stonecutter, three years with pneumatic hammer. He complains of a numbness in the four fingers of the left hand (he is right-handed), and this is increased on cold days to the point of pain and marked discoloration in fingers. He has no stiffness. He has gained 14 pounds in weight since entering the service. There is no interference with his movements while at drill after he has exercised sufficiently to get fingers warm. Physical examination showed no cyanosis and no anesthesia.

No. 7 has had eight years' experience as a stonecutter and eight years' use of pneumatic hammer. He complains that the second, third, and fourth fingers of the left hand constantly have a peculiar, dull feeling which is more marked on cold days. He has noticed this condition for the past seven years and believes it is due to the gripping of the chisel, and the vibration of the pneumatic hammer; he especially complains that the hand and forearm develop this dull, numb feeling if he sleeps with his arms above his head. He says there has been marked improvement since coming into Federal service and there is no interference with movements while at gun drill after his hands become thoroughly warm. There is a slight interference with movement previous, however.

No. 8 has had 14 years' experience as a stonecutter, eight years with pneumatic hammer. He complains of both hands becoming numb, more especially across the fingers on cold mornings. No such condition present on warm days. He says his movements are interfered with to a marked extent, and that he has dropped the piece while at gun drill because of the numbness. He has warm gloves but they do not warm the fingers and the only method by which he can restore a normal feeling in these fingers is by exercises, more especially finger exercises. There is no swelling and no discoloration normally, but on cold days, as I observed him, the fingers are markedly cyanosed with a marked partial anesthesia present.

REPORTS OF PHYSICIANS OF THE PUBLIC HEALTH SERVICE.

HEALTH HAZARDS FROM THE USE OF THE AIR HAMMER IN CUTTING INDIANA LIMESTONE.

BY J. P. LEAKE, PASSED ASSISTANT SURGEON, UNITED STATES PUBLIC HEALTH SERVICE.

Indiana limestone from the vicinity of Bedford, Ind., is at present the most important building stone in America. Beside its architectural qualities, its value is due largely to the ease with which it can be quarried and worked in large quantities. It is of fine texture, of the class called oolitic because of the small egg-like fossils of which it is composed, of even consistency, and comparatively soft to the tool.

The center of the industry is Bedford, a city of 10,000 population, the county seat of Lawrence County; Bloomington, a city of about the same size, the county seat of Monroe County, adjoining Lawrence County on the north, is next in importance as a stone center; Ellettsville and Stinesville, north of Bloomington, are smaller centers. Bedford has railroad shops and other small factories, but it is essentially a town of one industry—stone—while Bloomington is the seat of the State university and enjoys more varied activities.

There are 39 stone companies in the district. Though some of these engage in both branches of the work, a sharp line is drawn between the production of rough or machine-tooled stone and the production of dressed or cut stone. It is only the latter with which this investigation is concerned.

The greater part of the quarrying for Bedford is near Oolitic, a town of about a thousand inhabitants, 4 miles northwest of Bedford. For all but the preliminary squaring off of the blocks (the process called scabbling) the stone is brought to the mills in Bedford. These mills are very large buildings, some operating 7-ton or 15-ton electric cranes and containing tracks for the loading and unloading of freight cars. On account of their size and height, and the wide doors, they are difficult to heat; moreover, they contain no intrinsic source of heat, such as the furnaces of a steel mill.

In general, the blocks of stone from the quarries are first sawed into large slabs by reciprocating gang saws. These are strips of steel without teeth, the abrasion being furnished by a mixture of

sand and water, which is fed from above. Next, the slabs may be sawed by large circular saws with black Brazilian diamond teeth. This is also a wet process; the spray is largely gathered by the hoods over the circular saws. If the stone is not to be cut by hand, machine dressing follows next; steel cutting instruments are used on the planers, circular planers, and lathes without further moistening of the stone. In the planing machine the block of stone reciprocates on a bed beneath the tool, which takes off one layer after another in a coarse powder, producing fluting and other straight line figures which were formerly cut by hand.

The stonecutting (hand cutting) is usually done at one side of the main craneways, and, as observed at the time of this investigation, the air hammer was almost entirely employed for this work, except in the case of the apprentices, who are required to use the mallet in the old-fashioned way. This work, whether plain cutting or carving more intricate figures, such as statuary and Corinthian capitals, is done in two parts, called "roughing out" and "cleaning up." In "roughing out" the block of stone is roughly shaped to the form which it is finally to assume, and the steel hand hammer or wooden mallet is occasionally used to deliver the impacts; this part of the work is less exacting and less time-consuming than the finishing or "cleaning up" for which the pneumatic hammers appear to be used exclusively by the journeyman cutter. But the division between "roughing out" and "cleaning up," as that between plain stonecutting and carving, is not a sharp one.

There are normally 200 or 300 stonecutters in Bedford, 50 to 75 in Bloomington, and smaller numbers in Ellettsville and Stinesville. On account of inactivity in stone construction, much smaller numbers were found employed, and the employment varied from day to day. In general, however, the employment has been fairly steady and permanent; the stonecutters are a superior class of workmen, many owning excellent homes. Their hours of labor are strictly limited to 8 per day and 4 on Saturday, 44 hours a week. The wages at the time of the investigation were 67½ cents an hour. The carvers are not hired directly by the mills, but this work is let to subcontractors, who employ other carvers, by the hour, to help them.

In the stone industry, pneumatic tools were probably first used on granites and the harder stones. The first air hammer was introduced in Bedford about 22 years ago, and use of these hammers became universal in this district about 7 years ago. The air compression is maintained by steam air pumps and tanks at about 85 pounds per square inch, and is piped to the place of carving. Flexible pressure hose connects the air pipes with the hammer; the air is turned on for each hammer by a thumb cock in the rubber hose about 3 feet from the hammer. Various makes and sizes of pneumatic hammers were

seen. The reciprocating strokes are produced by the piston alternately opening and closing inlet and exhaust openings at various points on the interior of the cylinder (piston valve) and thus responding to the force of the air pressure.

The tool is not attached to the hammer, but must be held in the point of the hammer by the hand. The tools are about 10 inches long, including a butt of about $1\frac{1}{2}$ inches which fits into the hammer. The diameter is variable, frequently about half an inch, giving a weight of about 9 ounces.

The dimensions of two hammers frequently used are approximately as follows:

	Three-quarter inch.	1 inch.
Total length.....	6.7 inches.....	8 inches.
Total weight (without tool).....	$1\frac{1}{2}$ pounds.....	$3\frac{1}{2}$ pounds.
Outside diameter.....	1.2 inches.....	1.6 inches.
Inside diameter.....	$\frac{3}{4}$ inch.....	1 inch.
Inside length (cylinder).....	2.6 inches.....	2.8 inches.
Length of stroke.....	0.9 inch.....	1.07 inches.
Diameter of piston.....	$\frac{3}{4}$ inch.....	1 inch.
Length of piston proper.....	1.7 inches.....	1.73 inches.
Length of piston rod (for impact against tool).....	0.9 inch.....	1.5 inches.
Weight of piston (with rod).....	6 ounces.....	3 ounces.

By means of a tuning-fork mechanism the rate of vibration of various tools was measured.¹ The apparatus consisted simply of a copper platen attached by an adjustable clamp to the tool whose vibration was to be measured. The platen was smoked after being fixed to the tool, by moving it over a bit of ignited camphor. While the tool was being used on a piece of stone, a tuning fork, with tracing point attached, was drawn rapidly across the platen. If the tool were not vibrating, the resulting curve would show merely the smooth vibrations of the tuning fork. If the tool vibrated at the same time, the compound curve would show a certain number of the smooth tuning-fork vibrations and also the sharp strokes of the tool, giving peaks different in shape, height, and number from those caused by the tuning fork. The ratio of the number of the former peaks to the number of the latter in a given distance on the tracing gives the rate of vibration of the tool when that of the fork is known.

Various hammers, even of the same size and type, and with the same registered air pressure, were found to give rather widely varying rates of vibration, dependent apparently on the pressure exerted by the stonecutter against the stone and on the lubrication and amount of wear of the hammer. It was soon found that with a range of tuning forks the rate of vibration could be gauged fairly accurately by comparing the pitch of the main note given by the vibrating

¹ The writer is indebted to Prof. A. L. Foley of the Department of Physics, Indiana University, for suggesting and perfecting the details of this apparatus. It is simple and appeared to be the most accurate of several which were considered.

tool with that of the tuning fork corresponding most closely to it. However, especially when forks with low amplitude of vibration were used, it was found that accessory vibrations of the tool, sometimes two or three times as frequent as the main vibrations, were recorded on the platen; these were presumably caused by the elasticity of the stone and steel, the tool reverberating between the stone and hammer after each stroke of the piston. With 85 pounds' pressure, the 1-inch hammer gave a main vibration rate varying between 88 and 136 per second (5,000 to 8,000 per minute), and the three-fourths-inch up to 167 per second (10,000 per minute). This is much more rapid than the figures usually given, and still does not take account of the more rapid accessory vibrations.

The hammer itself is held by a right-handed person in the right hand, between the thumb and forefingers in much the same way as a pencil or pen is held. Some of the stonecutters regulate the power of the stroke by holding the thumb or forefinger over the exhaust. This may create a callus or a small area of insensibility at times, but does not appear to be productive of any serious results. The tool is held in the left hand, the most powerful part of the grasp and that controlling the direction of the cutting edge being exerted by the ulnar part of the hand. The direction of the hammer and tool is diagonal to the surface of the stone, and the rotation of the chisel about its own axis as well as the depth of the cut must be controlled very accurately. Since the tool is slender and rotates freely in the hammer, this necessitates a very firm and constant grip with the left hand. These points are important, as will be shown later. Some of the air hammers, presumably those which were considerably worn, were observed to discharge air along the piston rod and tool, against the fingers of the hand which held the tool. This was not observed to cause serious discomfort, but may have interfered with the power of the stroke.

The work is fairly continuous. Frequent changes of position and interruptions to blow away dust, make measurements, and change tools occur, but the hammer is in the hand and operating for the greater part of the time. Competition in speed, in part stimulated by the foremen or subcontractors, in part natural to the stonecutters, is probably keener than in smaller shops under the old conditions of stonecutting; in Bedford, stonecutting has been transformed to a factory occupation.

Heat was furnished in one of three ways: First, by hot-air conduits opening in the vicinity of the stonecutters; second, by steam pipes around the side of the building; third, by coke-burning salamander. Of these the third appeared to be the most efficient, and the mills are so open that danger from carbon monoxide poisoning was minimal. However, since cold appears to be a factor in the production of dis-

comfort from the use of the tool, it would be advisable to install radiators, or other devices for heating the tools and the hands on cold mornings, in closer proximity to the cutters than the hot-air conduits and the steam pipes. The temperature in the mills is much less severe than in the open sheds where stonecutting has customarily been done. In one mill where the outside temperature was 16° F. at 7.30 a. m., the temperature where the stonecutting took place was observed to be 36° F. at the same time. In another mill the inside temperature was 40° F. when the outside temperature was 22° F.; in a third the inside temperature was 40° F. when the outside temperature was 26° F. In two metal plants where pneumatic tools were being used the temperatures were 45° F. and 62° F. when the outside temperatures were 19° F. and 21° F., respectively.

As regards lighting, conditions were satisfactory. The stonecutting is usually done at one side of the mill and therefore near windows.

OTHER USES OF VIBRATING PNEUMATIC TOOLS.

The use of pneumatic tools was also observed and tried in drilling holes in limestone, in cutting granite and other hard stone, in riveting metal plates, in calking boilers, in chipping castings, in cutting metal preparatory to calking, and in cutting grooves on sheet metal.

In the mills and at the quarries, reciprocating pneumatic drills; called "plug drills," are used for drilling holes in the blocks of stone for hoisting and for breaking. These drills are much larger than the air hammers used in stonecutting, especially in length of stroke, and the rate of vibration is much slower. The hammer has a pistol or shovel grip, and the tool, or drill proper, is guided by the left hand only at the first application to the stone; when the hole has been started both hands grasp the hammer. Moreover, the drill is of larger diameter than the tool in stonecutting, and the grasp does not need to be so rigid or to direct the point so accurately as in the latter work.

In granite and monument cutting, the air hammer and tools are like those used in the Indiana limestone belt. Part of the granite cutting, however, is a pulverization of the stone, with the hammer and tool held perpendicular to the surface. It is apparent that when the work is of this character the grip on the tool is not of necessity as firm as when diagonal cutting is done. The main vibratory rates and the accessory vibrations were found to be similar to those in the limestone mills. The tendency toward vasomotor spasticity in the left hand (to be described later) was observed in the granite cutters, but not so uniformly nor to so marked a degree as in the limestone cutters.

In hot riveting outdoors and in hot and cold riveting in shops and mills the largest hand air hammers are used, those with pistons 1 $\frac{1}{16}$ -

inch diameter and a 9-inch stroke being a common size. These give about 20 vibrations per second. Here both hands are on the hammer, which usually has a pistol grip; the cap or "set" which hits the rivet is attached to the hammer by a spring clutch and does not need to be held. Riveting by sledge hammer was also observed; a rivet is headed as quickly by this method as by the use of the pneumatic hammer, but the strain on the men is much more severe. No cases of vasomotor spasticity were discovered among pneumatic rivet men.

In calking metal seams, a smaller hammer is used than in riveting, and the calking tool is held in the hand, but a firm, rigid grasp is not necessary, as the action of the hammer is perpendicular to the surface and the tool guides itself to a large extent.

The chipping preparatory to this calking, on the contrary, is inclined work. A triangular ribbon of steel is cut from the upper plate in order to make a bevel for calking. Grooving a sheet of metal is a somewhat similar process. Not so much attention, however, is directed in these cases to make the finished job smooth in appearance as in stonecutting, and the grasp on the tool is consequently not so rigid or continuous. The vibration rate is about 50 per second.

Chipping rough projections from castings is like the processes just described, but frequently larger hammers are used. Some of the tools used for this purpose have a hexagonal butt which fits into a six-sided opening in the end of the hammer snugly enough to prevent turning, but allowing free up and down motion. With the pistol grip, which is almost universal in pneumatic hammers for metal work, this enables the operator to guide the tool well with the hammer hand, and to relax the grasp on the tool to some extent. None of the metal workers who used air hammers admitted the blanching of the hands which was found so frequently in limestone cutters.

It is thus seen that in these other uses of the pneumatic hammer (except granite cutting, which is somewhat similar to limestone cutting) the rate of vibration is slower and the grasp on the tool less constrained and constant than in the occupation under consideration. We should therefore expect that if the vibration itself had any deleterious effect, this would be at a maximum in the case of the stonecutters.

THE PULMONARY HAZARD.

Though this investigation was primarily directed to ascertain the possible effects of the air hammer in producing nervous disorders, it was deemed worth while to secure some data on the pulmonary hazard, since dust is commonly supposed to be the one great danger in the stonecutting trade. The infiltration of the lung with dust particles is known as pneumokoniosis, in the case of stone dust, as chali-

cosis; the result is a fibroid phthisis giving rise to dyspnoea, less often to cough and expectoration, at times fatal in itself, but more commonly found at necropsy when the direct cause of death has been tuberculosis. We may therefore consider the dust as predisposing to pulmonary infection with tubercle bacilli—less often with pneumococci or other organisms—and we may expect to find chalicosis expressed in the death records as pulmonary tuberculosis.

All prior statistics based on this assumption class stonecutting as a somewhat hazardous occupation. In this country the census of 1900¹ recorded 33 per cent of the deaths among marble and stone cutters as due to pulmonary tuberculosis, while for all occupations (males) the percentage was only 14.5. In 1909² 28.6 per cent of marble and stone cutters, 14.8 per cent of all occupied males, and 21 per cent of all occupied females who died, died of pulmonary tuberculosis. Hoffman³ has reported the experience of the Prudential Life Insurance Co., 1907–1910: 47.8 per cent of the deaths among stone workers 25 to 44 years of age and 32.3 per cent of those 45 to 64 years of age were due to tuberculosis; among all occupied males the percentages for the two age groups were 38.5 and 14.1, respectively.

Through the courtesy of the officers of the Journeymen Stone Cutters' Association of North America, part of the death records of this organization were summarized. Of 343 deaths among stonecutters with assigned cause, 56 per cent were credited to pulmonary tuberculosis, stonecutter's consumption, and fibroid phthisis. On every count, then, stonecutters have suffered severely from chronic pulmonary disease, presumably caused by the stone dust.

I am indebted to Dr. Harvey Voyles, registrar of Bedford, for access to the original mortality records of that city, which are in good shape for the past 10 years, except for some uncertainty (as is common in death records) as to stillbirths; on this latter account only persons over 1 year of age were considered. To secure a basis for comparison, the United States Mortality Records were similarly summarized for 1910–1915, the middle six years of the past decade, since the records for 1916 and 1917 are not available. For the registration area, 11.3 per cent of all deaths in this age group (11.9 per cent in males, 10.5 per cent in females) were due to tuberculosis of the lungs, for Indiana 11.5 per cent. For Lawrence County, Ind., 12.6 per cent of deaths at all ages were due to pulmonary tuberculosis; for the registration area 9.4 per cent at all ages, and for Indiana either as a whole or disregarding cities of over 10,000 popu-

¹ Twelfth Census of the United States. Vital Statistics, Part 1, Table 8, p. 154. Washington: United States Census Office, 1902.

² Mortality Statistics, 1909. Tenth Annual Report. Table VIII, pp. 388, 402. Washington: Government Printing Office, 1912.

³ Hoffman, F. L. Exhibits of the Prudential Insurance Co. of America. International Congress on Hygiene and Demography. Pp. 24, 29. Washington, 1912.

lation in 1910, 9.9 per cent. The population of Bedford was 8,716 at the last census. The tuberculosis proportional rate in Lawrence County is thus seen to be above normal. But beside Bedford and the limestone mills, Lawrence County contains the town of Mitchell, near which are large cement factories. Cement works are notoriously dusty, and both locally and nationally have a reputation for high consumptive rates. The death rate per thousand from pulmonary tuberculosis in the registration area for the six-year period was 1.31, in Indiana 1.29, in rural Indiana including all of Lawrence County 1.24, in Lawrence County 1.60.

Among stonecutters in Bedford 15 per cent of the deaths during the 10 years were due to pulmonary tuberculosis. Among all the workers in the stone mills, including the planer men, 12 per cent of the deaths were assigned to this cause. No disproportionately high number of deaths was assigned to other respiratory or heart diseases, under which titles might be found fatalities really due to chalicosis. Among all other males of the same age group (23 to 72 years) the proportional rate was 13 per cent; among all females 21 per cent; among all persons over 1 year of age the proportional rate (from tuberculosis of the lungs) was 13.3 per cent, corresponding to 11.3 per cent for the registration area.

Objections might be raised to conclusions from these statistics in that for some items there were only a small number of deaths; also that the age groups were very broad and that proportionate percentages instead of actual death rates were compared. In regard to the small size of the items, it is to be noted that the classes are not subject to the allowances made for samples, but that they represent the total number of deaths. The age distribution was not strikingly dissimilar in the different classes. The possibility of consumptive stonecutters having left the trade or sought other climates is to be considered, but the higher percentage of tuberculosis in Bedford among females than among males would argue against the assumption; for if the affected stonecutters had left the trade, while still remaining in Bedford, we should expect a disproportionately high rate among the males of that age group as compared with the sex which is not subject to the hazard.

It accordingly appears that while Bedford has a proportional death percentage from phthisis slightly above normal, it has been no higher for stoneworkers than for other classes of the population, including females.

This agrees with what could be learned from a canvass of the physicians of Bedford and from the stonecutters themselves. The only case of consumption in stonecutters about which information could be obtained in this way was in a man who developed the disease nursing his wife through a fatal tuberculosis. No X-ray chest plates

were made, but in examining the man no symptom or sign which could be attributed to pneumokoniosis was found.

The mills were not as dusty as several granite monument shops which were visited, but the difference was not striking, except for the fact that in the monument shops the dust was in the air, while in the limestone mills the dust was almost entirely on surfaces. There are at least four conceivable explanations for the comparative immunity of the Bedford stonecutters: (1.) The particles may be larger and heavier than in the cutting of other stones; as one looked down the stonecutting aisles of these mills the visible cloud of dust from each tool stopped far below the face of the worker. In general the exhaust from the pneumatic tool blows what dust is formed away from the breathing zone. In limestone cutting the action of the tool is chipping at an acute angle with the surface of the stone; as explained before, in granite cutting the action is frequently perpendicular to the surface and possibly more pulverizing. (2.) The blocks of stone as they reach the cutter in the mills, though not visibly wet, retain some of the moisture from the sawing processes. This reduces the dustiness of the cutting. (3.) It is possible that the particles from the oolitic limestone are rounder and smoother than those from other stones; an accurate microscopical comparison was not made. (4.) By some theories, calcium salts have a beneficial action in tuberculosis, aiding in walling off chance lesions from further activity. In general, the cutting of limestone has been held to be less perilous than the cutting of sandstone or granite. In any case, stonecutters appear to suffer less in Bedford than elsewhere from the dust hazard.

Associated with the dust hazard is the hazard from flying chips, largely an ocular one. Only a small proportion of the men were observed to wear protecting goggles. But on account of the inclination of the hammer the direction of the chipping is away from the worker's eyes. The physicians and oculists in Bedford state that while eye injuries occur in the stone mills, the most numerous and severe are not among the workmen who handle the stone, but among the metal workers, machinists and tool sharpeners; stone particles rarely cause more than temporary injury.

THE NERVOUS HAZARD.

At the outset of the investigation it was observed that the stonecutters on cold mornings were likely to have the fingers and ulnar side of the left hand white, cold, and numb. The investigation was primarily directed toward ascertaining the seriousness of this condition and whether other nervous troubles might be attributable to the use of the air hammer. The general findings and conclusions in this

regard are given in Prof. Edsall's report. The writer is deeply indebted to Dr. Edsall for advice and collaboration, and for making by far the greater part of the more thorough examinations.

Many have considered the action of pneumatic tools to be unduly fatiguing or to subject the nervous system to some mysterious injury, but no data have been available sufficient to draw conclusions in the matter. Southard and Solomon¹ have reported a case of pain and numbness in the hand of a granite cutter, in whom they found a slight anesthesia demonstrable only by Martin's electrical sensory test. This cutter had used a pneumatic tube for 15 years; the Wassermann reaction was positive. In this investigation it was felt that changes in sensation perceptible to the examiner only by use of a faradic current and not by any of the ordinary tests or by functional ability, in the first place must be very slight, and in the second place, especially in the question of occupational neurosis, might be rather dubious.

The following form was used to record the histories obtained at the time of examination:

Name_____ Residence_____ Age_____

Years with air hammer____ Years with mallet____ Type hammer used____

Stone____ Character of work (roughing, finishing, carving)_____

Where_____ Finger complaint_____ Location_____

When first noticed_____

(Underline condition observed at examination.)

Other complaints:

Sleep_____ Pain_____ Numbness_____ Cold_____ Breath_____

Exhaust control_____ Along tool_____

Opinion as to best form of hammer and character of work_____

Date examined_____ Hour_____ Location_____

Temperature outside_____ Temperature where examined_____

Besides the 19 men examined by Dr. Edsall, three other cases were examined in detail because they were commonly reported to be among the most severe sufferers from the use of the air hammer. Two were said to have stopped stonecutting on this account, and had left the Bedford district. In none of the three was there evidence of any organic change of consequence which could be attributed to the hammer. On the right forefinger of one man there was an area of diminished temperature sense; this was the finger used in controlling the exhaust. Calluses interfered with pain and touch sensitiveness over part of the hands, and when the parts were cold all sensibility was obtunded, but not more in any of the three cases than was the case with the hands of the examiner.

Of those who had changed their employment supposedly on account of objections to the air hammer, one stated that he quit be-

¹ Southard, E. E., and Solomon, H. C.: *Occupation Neurosis*, p. 288 in Kober & Hanson's *Diseases of Occupation and Vocational Hygiene*. Philadelphia, 1916.

cause he had a disagreement with the foreman about another matter, a second had sought easier and steadier work, but found that two years of indoor occupation made him more nervous than cutting stone with the air hammer. A third had been badly frightened by hearing a severe prognosis made as to the possible effects of the hammer; he was habitually nervous and apprehensive in using the pneumatic tool, but stated voluntarily that he would like to go back if it were improved so as to relieve the strain.

When the stone mills were visited soon after work started in the morning the greater part of the cutters and carvers showed a blanching of the ulnar part of the hand which held the tool, with numbness and lowered temperature. They stated that this occurred commonly, but not uniformly in any one subject, in winter and on cold, damp, spring mornings. It also occurred frequently when the hands were subjected to cold in any way. It could be brought out in many of the men weeks or months after they had stopped work by plunging the hands for a few moments into snow or cold water. The hands of the examiner, used as a control, would under these circumstances show the normal hyperemic reaction, as did also the right hands of the stonecutters usually. On the left hand, typically, the little finger and hyperthenar eminence, the ring finger, and the tip of the middle finger became white and nearly bloodless. This might involve other fingers and the palm of the hand. If the person were left-handed, the right hand would show the phenomenon.

Designating the digits as 1, 2, 3, 4, 5, in order from the thumb to the little finger, the following table indicates the distribution of this vasomotor hypertonicity as to the fingers affected:

DISTRIBUTION OF BLANCHING, BY FINGERS.

Case.	Tool hand.	Hammer hand.	Case.	Tool hand.	Hammer hand.
1.....	5	.....	22.....	3, 4, 5	.....
2.....	5	.....	23.....	3, 4, 5	.....
3.....	5	.....	24.....	3, 4, 5	.....
4.....	5	.....	25.....	3, 4, 5	2
5.....	4, 5	.....	26.....	3, 4, 5	3
6.....	4, 5	.....	27.....	1, 2, 3, 4	.....
7.....	4, 5	.....	28.....	3, 4, 5	2, 3
8.....	4, 5	.....	29.....	2, 3, 4, 5	.....
9.....	4, 5	2, 3, 4	30.....	2, 3, 4, 5	.....
10.....	3, 4, 5	.....	31.....	2, 3, 4, 5	.....
11.....	3, 4, 5	.....	32.....	2, 3, 4, 5	.....
12.....	3, 4, 5	.....	33.....	2, 3, 4, 5	.....
13.....	3, 4, 5	.....	34.....	2, 3, 4, 5	.....
14.....	3, 4, 5	.....	35.....	2, 3, 4, 5	.....
15.....	3, 4, 5	.....	36.....	2, 3, 4, 5	.....
16.....	3, 4, 5	.....	37.....	2, 3, 4, 5	2
17.....	3, 4, 5	.....	38.....	2, 3, 4, 5	2
18.....	3, 4, 5	.....	39.....	1, 2, 3, 4, 5	.....
19.....	3, 4, 5	.....	40.....	1, 2, 3, 4, 5	.....
20.....	3, 4, 5	.....	41.....	1, 2, 3, 4, 5	.....
21.....	3, 4, 5	.....	42.....	1, 2, 3, 4, 5	12

1 Little finger held under tool.

The greater number of the cutters showed the condition on the cold winter mornings during which the investigation was in progress—in one mill 5 out of 6, in other mills 6 out of 7, 2 out of 4, 4 out of 7, 8 out of 11, and 5 out of 7. Usually, decided discomfort was experienced when the blood returned to the hand, but the work was not seriously interfered with. The apprentices, who did not use the air hammer, had colder left hands than right, but no clear history was obtained of the typical reaction in its marked form in men who used the mallet exclusively. A former boiler builder, now one of the sales force for the boiler factory, who never used a pneumatic tool and had not heard of the above condition, described the same phenomenon as occurring in his left hand, following the use of hand tools in the boiler shop.

It is noteworthy that many of the older stonecutters state that they formerly had trouble of this sort, but do not have it at present. It is their belief that the younger workmen grip the tool too tightly. This spastic anemia, however, was sluggish in onset, taking months or more than a year for full development, and lasting equally long after the cause was removed; it occurred only in cold weather, and not continuously then. In spite of thorough search for the worst cases in and out of Bedford, no suggestion of any more severe changes than those described was obtained. There seemed no tendency for the anemia to go on to frostbite or necrosis. The use of gloves did not prevent the blanching.

Other nervous symptoms encountered bore more or less relation to the hand phenomenon. Sleep was disturbed in some cases by the hands and arms becoming numb very readily. Pains, particularly confined to the left side and extremities were occasionally described, but did not appear to be more severe than would be encountered among groups of workmen of the same age and habits who did not use pneumatic tools. Those unaccustomed to the air hammer unquestionably suffered more severely from these functional nervous symptoms. A few minutes' early morning use of the hammer in cutting stone (longer than a momentary trial) gave the writer an unpleasant, cramped, slightly painful sensation in the fifth digit and the ulnar side of the left hand, during the entire evening, with observable redness and swelling. The phenomenon was noticed before the use of the hammer was recalled. Recovery was complete over night. The factors concerned were evidently similar to the ordinary local fatigue and strain such as are commonly experienced from an unaccustomed employment. This is in agreement with the frequent statement of the stonecutters that their chief difficulty as regards nervousness and sleeplessness was when they began to use the tool, but that as they became used to cutting stone with the air hammer these symptoms wore off. The development of the white

fingers, however, is said to be more gradual, coming on in the winter after the pneumatic tool had been in use for some months.

It appears, then, that the continued use of the air hammer in cutting limestone leads to a disorder shown by a blanching of parts of the left hand, with cold and numbness; that this is not a serious disease, but in some cases decidedly disagreeable, and that measures should be instituted to prevent it. Of the three assigned causes, cold would appear to be merely the exciting cause. It would nevertheless be advisable to provide radiators or other means of heating the hands and tools of the stonecutters, giving a source of heat nearer to the working places than the present pipes and hot-air conduits. Of the two other factors, the strain caused by the cramped position of the hand in grasping the narrow tool, and the vibration, the former would appear to be dominant, but the vibration can not be eliminated as a cause since the phenomenon apparently does not occur in metal workers who use hammers with much lower vibratory rates, but who nevertheless guide the tool in somewhat the same way as do the stonecutters. The sensation imparted to the hand by the slower vibration is very different from that felt in the use of the air hammer in the stone works.

It has been suggested that changes along one or more of the four lines indicated below might be effective, but the problem is essentially a mechanical one, the object being to make the grasp of the left hand more comfortable and less straining, and also if possible to relieve some of the vibration received by that hand. Until an effective method is in use, it is advised that there be periods of rest from the use of the hammer and narrow tool, to enable the muscles of the left hand to relax and change their position.

1. A tool of larger diameter would permit a more hygienic grasp. It is possible that due to the softness of the stone and the necessary accurateness of the work, the impact of a light tool is preferable to that of a heavy one, but it would appear that if pressed against the stone, it is the construction of the hammer and the air pressure which determine the impact rather than the weight of the tool. A heavy tool, moreover, would reduce the vibratory effect felt by the left hand.

2. The shank of the tool might be provided with a tight fitting cover of asbestos or other similar material. This would need to be very rigid in order to permit proper guiding of the tool.

3. Instead of a tight handle, as above, a handle permitting reciprocal but no rotary motion could be used.

4. The end of the hammer might be prolonged over the tool so that the left hand in guiding grasps this instead of the tool. The tool should then have a square or hexagonal shank or be provided with grooves to prevent any rotary motion, and should also have a spring catch such as the rivet set in a pneumatic riveter.

CONCLUSIONS.

1. The pulmonary hazard is much less in stonecutting in the Bedford plants than in stonecutting in general. This is unquestionably the great hazard in the trade and its relative absence in this center makes the occupation of a stonecutter here more healthful than elsewhere. The workmen are not exposed to severe weather, the workrooms are large and well ventilated. In some of the mills the sanitary conveniences and guards against the spread of intestinal infection are satisfactory, but in others improvements should be made.

2. There exists in the hands of stonecutters who use pneumatic hammers a hypertonicity of the blood vessels which shows itself as an exaggerated reaction to low temperatures.

This is not serious as to life or function, but is uncomfortable at times, and should be remedied. It is believed that this can be done without eliminating the tool, and suggestions are made to that end.

**REPORT TO SURG. GEN. BLUE ON THE SUPPOSED PHYSICAL
EFFECTS OF THE PNEUMATIC HAMMER ON THE WORKERS IN
INDIANA LIMESTONE.**

BY DAVID L. EDSALL, M. D.

In accordance with your request I went to Bedford, Ind., to consult with Dr. Leake in regard to the effect of the pneumatic hammer on the stonecutters. Leaving Boston at 2 p. m. January 5, I arrived at Bedford about 12.30 midday, January 7. Dr. Leake had so ably and thoroughly gone over the situation before my arrival that I was thereby enabled to accomplish a great deal in a few days. What I have to say is based in very considerable part upon points that he had elicited and at once demonstrated to me. The remainder of January 7, 8, and 9, including the evenings, in company with Dr. Leake, I spent in going over the situation with Mr. Griggs, president of the Journeymen Stone Cutters' Association, with other officers of the association, and with several of the employers' representatives, in inspecting the mills and observing the men at work, and in examining and talking with the men. On January 10 we went to Bloomington, both in order to see more of the men and because the feeling of the members of the stonecutters' association there appeared, from what we could learn, to have been more actively aroused than in Bedford, and we wished to get the most positive evidence we could.

We repeatedly requested Mr. Griggs, the local officers of the stonecutters' association, and numbers of the men in both Bedford and Bloomington to bring to us the men who complained most, or we got their addresses and went to their homes. None of the men whom we examined were sent to us through the employers and none were examined in the presence of the employers or their representatives. In Bedford we reached them chiefly in their homes, which had the advantage of making them and their households feel quite free to talk in regard to their condition. In Bloomington, Mr. Walters, the secretary of the local branch of the stonecutters' association, brought the men to us. In both places the men seemed extremely frank and open in what they said. They are as a class superior men in personality, education, and manner of living. It rapidly became apparent that because the symptoms that I shall describe occur frequently, and fear had been aroused in various ways that they might grow

worse, the anxiety of the men was due more to this fear of further and more serious results than to anything known to have occurred. In fact, several of those with the most pronounced manifestations said to me that if that was all that it would do they thought it of comparatively slight consequence. Their fears of bad results had apparently been largely aroused within two years by their interpretation of the opinions of some physicians who had seen some affected men but, who, so far as we could learn, had not actually studied the cases or the men's work carefully but had rather, somewhat naturally, based their advice upon the men's own apprehensions.

The symptoms seemed, from the statements of these men as well as from statements of men who use the air hammer in other trades, to be almost exclusively, if not entirely, confined to stoneworkers, and among the stoneworkers they occur almost entirely in those who work with soft stone such as the Indiana limestone. The reason for this becomes apparently clear when one observes accurately the manner in which these latter workmen use the air hammer and especially the manner in which they use the stonecutting or stone-carving tools, and when one compares this with the details of the work of others who use the air hammer. At the same time, this offers a clear reason for the location of the symptoms and to a considerable extent at least for their character, and it furthermore suggests some very apparent expedients that may be expected to reduce the discomfort and that, if properly developed through experimentation, would probably almost entirely or entirely do away with the effects which now, while apparently never serious, are easily demonstrated, uncomfortable, and justify a demand for a definite effort to overcome them.

The matter will be most evident if I first describe the symptoms and then the character of the work. As to the symptoms: Dr. Leake and I examined very carefully 19 men, and in going through the mills and upon other occasions we examined casually and talked with as many more. Dr. Leake, before and after my visit, saw many others. Nearly all of these men stated that they had then or had previously had, in very slight degree up to a decided degree, the condition that we were there to study. This consists of temporary blanching and numbness of the fingers when the hands are chilled. It occurs almost entirely when the weather is cold, or at least quite cool, and when they are exposed to the cold—not when they are in well-heated buildings. One or two, however, believed that they sometimes felt it in summer, and several said that it annoyed them when "in swimming" in summer. It occurs chiefly when they start work in the morning before they get "warmed up" and lasts from a few minutes up to one and a half or two hours. A few men said it tended to recur during the day when at work. It also tends to occur when they walk or drive in cold weather, and when the hands are

plunged into cold water or snow it can be brought out in a few moments. Indeed, any exposure to cold causes it to recur. In appearance and in sensation they say it is precisely like overchilling the fingers in winter so that they "go dead," the first stage of frostbite of the fingers. As in the condition just mentioned, there may be some tingling or actual pain when it comes on and there is usually tingling when the blanching passes off, at which time it is succeeded by a flush and congestion for a little time, and at this time there may be a good deal of discomfort or actual pain, which, as most people have experienced with chilled fingers, may extend up the arms. Occasionally this is described as severe, but usually they say "annoying" is a sufficiently descriptive term. The numbness usually does not interfere with the use of their hands appreciably. Occasionally they state that it makes them clumsy, slower, and less accurate in their work while it lasts. Its distribution is striking and important in relation to its causation. In the great majority of the cases it is noticed first in the ends of the ring and little fingers of the left hand; later it is felt predominantly, in many cases solely, in the fingers of the left hand. In most instances, when definitely developed, it is felt chiefly and is often even later confined to an area on the ulnar side, extending back to include the two distal phalanges of the little finger or the whole finger, and running diagonally across to the index finger where it involves only the last phalanx or a little more. It gradually increases in some cases until it involves the whole of all the fingers of the left hand, occasionally going back along the ulnar side to the wrist or over the whole hand to the wrist. The right hand is very much less frequently affected than the left and then usually less markedly. Ordinarily, when it occurs at all in the right hand, it is chiefly noticed in the thumb and index or middle finger. In a very few cases it appears to involve the whole of both hands. The only instance of that extent that I actually saw was, however, in a man from whom questioning brought out the fact that it had not appeared, as is usual, toward the tips of the fingers and slowly increased in area, but had come suddenly over the whole area when he had "frozen" his hands during a long drive in cold weather and had subsequently, upon exposure to cold, been always of that same extent, slowly diminishing in intensity. In this case, therefore, while work with the air hammer brought out the symptoms after they had once appeared, it did not seem to have excited them in the beginning.

The distribution of the symptoms seems to be explained by the manner in which these men hold the tool in the left hand and the hammer in the right; and, in the right hand, a factor of importance seems to be the practice of some of the men of controlling the exhaust from the hammer by pressing the thumb, index, or sometimes

the middle finger over the exhaust hole, a practice which the more skillful men say is unnecessary and undesirable.

Sometimes after prolonged work the men have flexor contraction of the fingers of the left hand for a few moments as they cease work—evidently because of the prolonged, constrained grip on the tool. This is significant chiefly in suggesting the origin of their trouble.

Beyond what I have described the men sometimes complain of lameness in the arms, shoulders, or chest. Two said they slept badly and twitched and turned in their sleep after working hard with the hammer. These two, however, looked to be in poor general condition. Various other symptoms of vague character and significance were learned of from some of the men. I may, however, for brevity's sake state here that neither questioning the men nor careful physical examination showed evidence that the symptoms mentioned, or any others outside those in the hands, were of any particular significance. They were rather such symptoms as some members of any group of men will always show when doing work, of whatever kind, that is at times hard work and often carried out in constrained positions. In making this last statement, I exclude any consideration of the effects of dust upon the lungs. I was not asked to study that and did not do so. I would say, however, that I was not impressed with any noteworthy need of studying the dust hazard, which in working with this particular stone seems surprisingly mild.

Some excitement had been caused by the fact that one stonecutter had died insane. This case the men themselves now dismiss, however, as having been due to general paresis. One man we saw had had an ordinary acute facial paralysis. Quite naturally, in the apprehension that had been aroused, such occurrences and various vague rumors and suggestions had led to fears of "paralysis," Raynaud's disease, and a variety of other grave results. We could find absolutely nothing to justify such fears, even in the stories we were told. It is entirely conceivable that a neurotic subject might grow decidedly neurasthenic from dwelling on the disagreeable sensation that these small pneumatic hammers produce. Some of the men said that the sensation was exceedingly disagreeable to them at first, but all except the nervously oversensitive soon get so accustomed to it that they pay no attention to it. It is, in this way, like many other accompaniments of industry, as for instance, the noise in many forms of work.

The symptoms in the hands seem to constitute all the recognizable effects of cutting and carving stone with the air hammer, and in describing the results of physical examination and in considering the cause and nature of the condition and the possible remedies, I should be understood as referring solely to these hand symptoms.

When the men were at work in the mills in the early part of the day, many of them showed in mild form and extent the blanching

described above. The finger nails and the affected fingers were sometimes cyanosed instead of blanched. When seen in houses or in our rooms just after they had come in from the cold the same conditions existed. The weather was severely cold during my stay there. After a short period in the warmth the affected area became flushed and then after a further period looked and, they said, felt normal. As I have said, except for occasional other symptoms that seemed to have no distinctive relation to the work, nothing else was observed and the men almost all stated that this was the whole trouble. One man showed fibrillation of the muscles of the left hand, but it was so slight as to be scarcely observable and such as is occasionally seen without definite cause and since no one else showed it, it was probably of no significance. None showed tremor except one who admitted the rather generous use of alcohol, and in him it was of the usual alcoholic character. When cold and blanched the finger movements were somewhat clumsy. When warm the motor power was normal. There was no muscle atrophy observable. The hand grip was normal, as were the wrist and elbow reflexes in all instances. Sensation to touch, to pain, and to heat and cold was tested. When blanching was present the sensation to pain and to heat and cold was of course often moderately blunted over the affected area but became normal in the warmth. In two instances there was apparently very slight persistent reduction of sensation in the last phalanges of the third and fourth fingers of the left hand. Three men showed much reduced pain sense in entirely irregular and changing areas over the hands and forearms, but one of these was mildly alcoholized at the time and the other two were of distinctly neurotic character, and since the sensory disturbance was quite as marked over the forehead, face, and neck, on both sides, it appeared, of course, to be unrelated to the vasomotor disturbance in the hands and of no significance in relation to the actual effects of the air hammer, except that a study of the hands and arms alone might easily have led to the decision that there were organic nerve changes.

It is to be noted also that most of these men, owing to the grit from the stone and the use of the tool and hammer, develop a very remarkable degree of callus on the palmar surface and naturally this is found particularly in the areas especially likely to be involved by the phenomenon under study. The thickening of the skin frequently extends up the sides of the fingers so as to leave soft skin on only the back surface of the fingers, approximately three-fourths of the finger surface being often somewhat calloused and also much of the palm and the outer ulnar surface. Naturally, over calloused skin the sensation, especially to pain, is somewhat lessened, but this was of course equally the case in those men who had symptoms and those who had none. It is important only in showing that one

might easily think mistakenly that there were persistent changes in sensation even when the hands were warm and normal-looking.

In the 19 examined the stereognostic sense was normal. It was examined especially because Mr. Griggs stated that the men sometimes could not distinguish coins by their feeling. In the 19 men I examined carefully the heart and blood pressure were normal in all but one, who showed a moderately high pressure. He told me, however, that he had had syphilis. In all the 19 the blood vessels felt normal, and in all pulsation of normal characters could be felt in both radial and ulnar arteries.

Aside from the callus there was no observable persistent change in the skin. It was interesting that there were, even in the men who had had symptoms for years, none of the redness and desquamation even that one sees after mild frostbite, and they had no persistent itching or burning.

The condition seems then to be purely a local vasomotor irritability and there seems to be no evidences of any nervous or other organic changes except possibly, in one or two cases, extremely slight and very localized sensory peripheral nerve changes. These were, however, doubtful and seemed insignificant at most and may occasionally be noticed in any workmen who bring to bear as much and as prolonged local pressure as these men do. In view of the fact that the men who get symptoms usually do so within six months to two years of the time that they begin the use of the air hammer and that a large proportion of these men we examined, as well as very many others, have used the air hammer for many years and nevertheless no worse results could be discovered, it is wholly reasonable to conclude that this comprises the sum of the results and no organic changes or more disturbing functional changes are likely to occur.¹

We were unable to see or to learn of any cases in which the condition described actually interfered with the men's occupation as stone workers, though we were told of two or three cases in which they gave up this work either because of the discomfort it caused in cold weather or because of apprehension that it might grow worse. There does seem some possibility of its being a distinct disadvantage if the man wishes to go into certain other forms of work that cause exposure to cold. One man told me he had originally been a car builder and after using the air hammer in stone work he tried to go back to his old trade because he had had difficulties with the fore-

¹ It is of some interest to note that one, and I think also a second, man said when seen a few days before by Dr. Leake, that he had tried to bring out the phenomenon by plunging his hands into snow, but was surprised to find it would not appear, though usually marked. He said that he remembered afterward that he "had had a couple of drinks of whisky just before." This is of interest and of some importance in that it indicates both the mild character of the disturbance and its apparently purely vasomotor origin, since it was entirely overcome by the mild vasodilator action of the moderate amount of alcohol.

man in the stone mill, but had to give it up because he could not hold a cold chisel firmly with his numb fingers in cold weather.

We were told of several young stonecutters who had been drafted into the National Army and who were having a very uncomfortable time in the cold weather, especially in carrying a rifle. Gloves do not suffice to prevent the effect of quite cold weather.

However, skilled stonecutters, naturally, usually stick to their trade and, as stated, I found none whose stone work was either prevented or seriously interfered with. One man of those seen had given up working on limestone and was using the hammer with comfort in working on granite. Both tool and hammer are used differently on granite. Five men stated that they had earlier had the trouble decidedly but that it had gradually lessened until it had almost entirely disappeared. They attribute this to having learned to use the tool with greater skill and especially with an easier and less cramped grip. Other experienced workmen told me the older and more skillful men are bothered less than the younger and less skilled, and attributed this to the same cause and to the fact that the young men use the mallet little in "roughing out," while the older men have more familiarity with the mallet and use it a good deal. Mr. Griggs stated also that it is more common in the young men than in the older. He believed this due to the more common use recently of the larger hammer, but the older men state that they use the larger hammers as much as do the younger men.

In considering the cause, the precise character of the work must be appreciated. It is easy to see, when one tries himself some of the various uses of the pneumatic hammer, how peculiar results may occur with soft-stone workers. In the first place they use hammers of very rapid action. We were unable to get a reliable and definite statement as to the number of blows delivered by these and other air hammers. Dr. Leake is endeavoring to determine that accurately. It is said to be with the smaller of these hammers approximately 3,000 to 3,500 a minute, with the larger, 2,000 to 3,000. Whatever the exact figure the blows are so frequent that they can not be appreciated individually by the ear but make a continuous note. Whereas the hammers used in riveting, and most other metal work, act much more slowly and the individual blows can be heard. The vibrations are therefore much finer and more frequent in the hammers used by the stonecutters. The difference one appreciates at once when holding the hammers at work.

Probably much more important in explaining the special occurrence of these symptoms in the soft-stone workers is the manner in which they hold the hammer and more especially the fact that they work with a tool held by the left hand in a peculiar manner. The riveter simply grasps his (larger) hammer with both hands in a

manner convenient to reach the rivet with it. There is no loose tool to be held. The granite worker holds the hammer perpendicularly grasped in his right hand and while he does use a tool in the left hand it does not need to be gripped firmly or guided forcibly except in doing lettering or other fine work. These workers in limestone, however, hold the hammer in the right hand as one uses a pen, whatever force is exerted upon it being exercised by the thumb, fore, and middle fingers; and the tool, like the hammer, is held obliquely, in the left hand, is gripped firmly, held closely against the stone, and guided, by a pressure exerted especially by the last two fingers and running along a line which is practically that which I described as delimiting the extent toward the hand of the vasomotor phenomenon as usually seen in the left hand. The use of the left hand in calking and chipping seems superficially to be much the same but when one tries it, it is at once apparent that in these operations the tool needs relatively little guiding or pressure and for this reason and because the tool is larger (the shank of the stonecutting tool is only half an inch or often less) the grip of the left hand is very much less forceful and constrained than with the soft-stone workers. It will, I think, be apparent that the symptoms in the latter correspond in area closely to those areas of the fingers that are forcefully used and extend from there peripherally. It is to be remembered that these men use their hands continually, for most of their working days, in this manner unless they get frequent change by using the mallet. But, as stated, most of them nowadays use the mallet little. It is interesting that some of the men state that they had the same symptoms when working in earlier years with the mallet, but apparently this was unusual and the symptoms then ordinarily were slight.

There are three chief factors that evidently may play a part in producing the symptoms—cold, constriction, and vibration. Cold is evidently the chief factor that temporarily excites the symptoms, as few of the men have any trouble except in the cold. But in the many other trades in which the hands are equally exposed to cold this phenomenon is unusual. In fact the stonecutters were in earlier years, when they used the mallet, more exposed to cold than now. I am inclined to believe that cold elicits the symptoms rather than produces them, but it nevertheless gives the man discomfort. The factors more peculiar to this trade are the constriction of the grip exercised and the vibration. The vibration occurs almost equally, if not equally, in other work, as in hard-stone cutting, with relatively little or no such effect; also, if the vibration were the chief cause the affection would be expected to occur more diffusely over the hands, since the whole hand feels the vibration, and in more irregular distribution, and particularly it would be expected to spread radially

from the source of vibration instead of being, as it is, observed peripherally only for a long time, in most cases, and usually first in the finger tips. It seems probable that the most important factor and hence the one to be especially obviated is the continuous constriction. Much the same phenomenon may be temporarily and easily brought out in most persons in cold weather by a similarly strained continued grip. It can not, however, be either denied or affirmed with the evidence at hand that the vibration is a factor of importance.

It is obvious that certain simple things may be done to attempt to eliminate the trouble. First of all the shank of the tool, where it is held, could be made larger so that the grip need not be so strained. And in doing this it would be well to use some substance that would conduct cold, or heat, poorly, instead of the cold metal used as at present, that intensifies the effect of cold. Asbestos suggests itself and its practicability could be tried. Some of the men have tried rubber hose drawn over the tool but said it tended to work upward on the tool and choke the action of the hammer. One man, however, said that he soaked the hose in oil, drew it on his tools, and allowed the softened rubber to adhere to the tool in drying and thereby was able to use it successfully. He said that he had earlier had "dead fingers" but is no longer troubled by them. Asbestos, if practical, would have evident advantages. Some such handle would perhaps serve also to some extent as a shock absorber and thus reduce the possible effects of the vibration. It is possible too that practicable methods of keeping the tools warm in cold weather could be easily devised and would reduce the discomfort. It is also to be noted that the practice of controlling the exhaust with the thumb or fingers of the right hand should be discontinued. In the same connection it is to be observed that in some hammers, due either to their construction or to wear, the exhaust leaks downward along the tool (which it should not do), giving a slight constant blast of cold air on the left hand. This should be obviated. Heating the compressed air has, I believe, been tried but meets with difficulties and I do not believe it would be of much value even if successfully done.

Reducing the time spent at any disadvantageous work and shifting to other forms of work is in many kinds of industrial disorders sufficient largely to overcome the trouble. In this instance there is an obvious way of accomplishing this—by requiring the men to use the mallet in suitable parts of the work, especially in "roughing out." The operators say they have always preferred that this should be done, especially because compressed air is expensive, but that the men will not do it. The men admit they use the hammer in such work when they do not need to, partly because they get more done, and because, they say, unless they do the foremen look unfa-

vorably upon them and are likely to drop them because they do not work so fast. Evidently adjustments and understandings are needed on both sides here. The men and the operators and their foremen should recognize that the frequent shift to the mallet may go far to obviate the trouble. While the tool is held in much the same way when employing the mallet, there is a slight, almost automatic, relaxation of the grip on both the tool and the mallet handle after each blow and this alternating relaxation and contraction is just the desirable offset to the constant constriction exercised when using the air hammer.

Mr. Griggs stated that he believed the 1-inch hammer should be done away with in this work and only the three-fourths-inch hammer used. The men differ very much on this point. Many think the smaller hammer gives them more discomfort. Certainly the immediate sensation one gets in using it is more disagreeable than with the larger hammer owing to the more frequent and finer vibrations. From the evidence at hand, I do not believe that it is possible to say whether limiting them to the smaller hammer would help directly. But it would perhaps lead the men to use the air hammer less in "roughing out," and if that were the case it would probably indirectly do good.

Besides these obvious measures there is little doubt that, having in mind the above-mentioned factors that are probably active in producing the trouble, an ingenious person of mechanical training and familiar with the practical needs in the work could by some study and experiment devise changes in the tools or the hammer or other changes that would improve upon the above suggestions; and if the latter were not of the character needed, he could devise means that would be successful. While the disorder is not, under present conditions, such as to justify any fear of more serious results, it is uncomfortable and possibly of some economic disadvantage to the men and it is due to them that such studies as the above be made by the manufacturers of the hammer or more especially by the soft-stone operators, since of those who use the pneumatic hammer, it is their interests that are particularly involved.

PART III.—STATEMENTS OF PHYSICIANS REPORTING ON BEHALF OF THE EMPLOYEES AND THE EMPLOYERS.

Testimony of four physicians is here presented.

The report of the first physician, Dr. C. E. Cottingham, of Indianapolis, covers seven cases whom he examined particularly, at the request of the Journeymen Stone Cutters' Association, to determine the effect, if any, of work with the pneumatic hammer. His statement is more emphatic than that of any of the other three doctors. This is perhaps to be explained by the fact that the examinations were made at a time when the use of the air hammer was the subject of sharp controversy between the union and the employers, and the statements made to the doctor by these men—statements which he has accepted unquestioningly—may have been colored too highly because of the state of war that existed. He declares that if other stonecutters are affected anywhere near so severely as those he examined, the work is "permanently and irreparably affecting the nerves of their hands and, in some instances, their general health." He gives the symptoms as swelling, vasomotor change, and loss of sensibility in the hands, pain, loss of sleep, and general nervousness. In his opinion none of the cases he saw can become normal. He even goes so far as to say that he believes everyone using the hammer must suffer ill effects to some extent, and it is his belief that the use of the hammer should be controlled by law.

Dr. Cottingham's statement is as follows:

EFFECTS OF USE OF AIR HAMMER ON HANDS OF INDIANA OOLITIC-STONE CUTTERS.

BY C. E. COTTINGHAM, M. D., INDIANAPOLIS, IND.

I have recently had an opportunity to examine and inquire minutely into the effects and causation of a disease that is affecting the stonecutters who use the air, or percussion, hammer in their daily work. I have carefully and in several instances made repeated examinations of the effect of this disease in seven cases. I am informed that there are several hundred cases of this disease in the State of Indiana.

This being true, the matter has assumed grave proportions and has become a sociological question of which the State should take immediate cognizance. If the others are affected in any proportion as severely as those examined, they are doing or being required to do work that is permanently and irreparably affecting the nerves of their hands and in some instances their general health.

The disease is an occupational neurosis of which no reports have been made to the medical world, and I can find no literature whatever upon the subject. I have necessarily had to depend entirely upon my own observations and the evidence as given me by the patients examined.

I have no reason to doubt a single statement made to me by any one of the patients. My own observations showed me objectively enough to warrant the statement that all that these men state of the pain they suffer is true.

Appended you will find a detailed report of each case. It is necessarily condensed and shows no evidence of the amount of work necessary to obtain the information. I have excluded everything except the facts that are significant in relation to the disease in question. I have used the patients' expressions in describing their symptoms to a large extent and do not present this report as a strictly scientific one.

First, I will state that these men were all strong men physically. They had the appearance of men accustomed to hard work and men who were stoics and not afraid of fatigue or pain. They would not complain unless there was occasion for complaint, and I do not believe they exaggerated in any particular.

Briefly stated, the symptoms of the disease are as follows:

Swelling in hands.—The first symptom of which they complained was the fact that their hands swelled soon after beginning to use the hammer. Sometimes they swelled for five or six weeks. In one case the hands would swell every time he began using the hammer after a lay-off. One reported a lump the size of a hen's egg that appeared on the back of the hand and remained for two or three years.

Vasomotor change.—They all complained that their hands became white on exposure to cold. This was a vasomotor change that is natural enough, although people do not permit their hands to become cold enough to become white. In these men it is probable that the hands became white at a higher temperature than in most people. It is also probable that their hands are so numbed and rendered insensible to temperature changes that the men are not conscious that their hands are cold until the latter become white.

Loss of sensibility.—They all complained that their hands were numb. This numbness was variously described. Some said that it seemed that their hands, especially their left hands, were dead; that they were not a part of them; that they could not tell they were there except when they looked at them. Especially was this true on cold days. One said he could put his hand into boiling water until the skin came off and not know it; another that his hand felt as though it was in cold water all the time. They all said that they frequently felt as though their hands were asleep, as if they had pins and needles sticking in them. Some said they felt this effect whenever they held their hands in one position for 15 minutes. This numbness is a real thing and was proved to exist by my examination.

They had lost the pain sense to a considerable extent, because I would stick them with a sharp needle and they could not tell whether it was sharp or dull; even when I pressed until the needle penetrated the skin they were not conscious of it.

They had lost tactile sensation in their hands to a considerable extent. They could not tell when touched with cotton as when a fly crawls on their skin. They could not tell when they were touched or the location, even when slight pressure was used.

They had lost the temperature sense in the hands. They could not tell hot from cold when I would use test tubes, one filled with almost boiling water, the other with ice water.

I will state that these observations were confined to the hands. These men were normal in their nervous systems throughout the rest of their bodies. The lack of pain sense in their hands was more especially shown in their tolerance of electricity. With one electrode in one hand and the other in the other they could all tolerate 90 volts, using the combined galvanic and faradic currents, and apparently show no evidence of pain. When the electrodes were passed up to their wrists they would immediately show evidence of a normal condition and be unable to tolerate such a current for an instant; when I would measure the amount of current passed, I would find quite a difference in conductivity between their hands and their wrists. Thus when the current was passing through from the electrode in one hand to the electrode in the other hand with 80 to 90 volts there would only be from 8 to 12 milliamperes measured on the meter. If one electrode was passed up to the wrist there would immediately be registered from 20 to 25 milliamperes as passing. This difference is not present in the normal man. It may be interesting to note that I am unable to tolerate more than 50 volts from the same wall plate administered in the same manner without suffering acute pain. Yet these men tolerated 90 volts without apparently feeling it, and I was unwilling to test their endurance further, and so did not find out their limit.

Pain endured.—They all complained more or less of pain. Some said they did not have pain while working but suffered for several hours after working. One or two would suffer nearly all night. The pains were generally confined to hands and arms, especially the left hand and arm. One or two could not raise their arms, without pain, to the level of their shoulders. Some had pain in their necks. Others described various pains in their sides, backs, and calves of legs. Some had the pain while working. I think all said they suffered pain while working when they had to hold the machine in a certain position for a long time, as when they were cleaning a flat surface or when "straight tooling."

They all said they had pain when their hands were cold. One said he did not have pain except when his hands were cold, and then only while he was "warming up." Incidentally he remarked that he had fainted two weeks ago because of the pain while he was warming up. A big, strong man who denies he has pain except when he is "warming up" does not faint from pain unless that pain is severe.

Loss of sleep.—Five of the cases said they could not sleep after working with the air hammer. Two had quit work on account of the doctors' orders. Some said they could not sleep more than two or three hours. Some lost weight from 20 to 50 pounds while using the hammer.

Difference in blood pressure.—I took the blood pressure of all examined. In only two was it higher than normal. One I had a chance to observe for several weeks. I took his blood pressure weekly for three weeks while he was working and found his systolic pressure ranged from 150 to 157; diastolic, 100. The last time he had not used the hammer for several days and his blood pressure was 140, systolic; 100, diastolic. This was in a man of 50 years of age.

General nervous condition.—These men were not the kind of men you would describe as "nervous." In three of the cases the general nervous system did not seem to be affected, but in the other four there was a profound effect as shown by loss of sleep, loss of weight, worry, fear of loss of mind or health, and increased blood pressure—such effects as will come to anyone who suffers a continuous, nagging pain for a long time. They reported that one case had become insane and died in a short time, and that this man had been warned by his doctor that he must quit his work or he would go insane. Two of the cases had the fear that the same fate would befall them.

In no case, in my estimation, would there be any improvement while working. How much improvement could occur if they stopped work with the hammer is problematical. The cases examined, in my estimate, can never become normal again, although they may improve enough so that they will not suffer pain and may be fairly comfortable; but I do not believe their hands can ever regain their sensibility. These men state that when they work a short time each day with the hammer and the rest of the time with the chisel, in the old way, they can get along fairly comfortably.

In other words variety of occupation will not produce the sad effects evidenced in their cases. How much of the air-hammer work they can stand without ill effects will unquestionably vary in each case and could only be determined by experimentation.

But these men are irreparably damaged, and anyone who observes this hammer in its rapid, violent vibration must realize that no man can hold it firmly in his hands frequently in a strained position for eight hours a day five and one-half days in the week, week after week, and year after year, without its producing evil effects.

The effects may be confined to the hands in some cases and be evidenced only by pain, numbness, and local effects. In other cases it will affect their nervous system generally and they will become neurotic, neurasthenic, and, in some cases, insane.

I do not believe anyone can use it, working with it continuously, without ill effects in some way, and in a certain not small percentage it must necessarily produce the most profound effect. I believe the use of it should be limited and controlled by the law.

Case No. 1.

[Employee No. 23 (see p. 24).]

Age, 39; white; American; married.

Family history: Negative; has one child living and healthy.

Previous history: Has always been well until last few years. Has been a bonecutter for 21 years; used the air hammer 8 years.

Patient's statement: Is well except in hands, arms, and neck. Left leg is affected and seems numb. Left arm and hand seem dead—"go to sleep" when left 15 minutes in one position. Is much worse in cold weather. Three fingers on right hand are affected the same way; all on the left hand seem dead. Can put hand in boiling water until skin comes off without feeling it. Pains when cold. Pains in neck at times; attack lasts about two weeks, when he can not move his head without intense pain. Pain is in the region of seventh cervical vertebra.

Physical examination: Strong, well-nourished, well-muscled individual of average height, and weight physically normal.

Neurological examination: Normal, except diminished tactile, temperature, and pain sense in hands; worse in left hand.

Claims he has pain in middle third of left upper arm. Can not raise arm squarely above level of shoulders.

Blood pressure: Systolic, 140; diastolic, 80.

Electrical conduction: Using 75 volts, there was a difference of conductivity between fingers and hand on wrist. Fingers and hands, 8 to 10 milliamperes; wrist, 16 milliamperes.

February 22. Blood pressure: Right arm, systolic, 157; diastolic, 100; left arm, systolic, 140; diastolic, 100. Electrical conductivity (90 volts used,

electrodes in both hands): Six to 10 milliamperes on fingers and hands; 20 milliamperes on wrist. Both hands the same.

February 23. Blood pressure: Both arms, systolic, 160; diastolic, 105.

Electrical conductivity: Both hands, 8 to 10 milliamperes (80 volts used); wrist, 16 milliamperes.

This man, in order to show the effect of cold, held his hand in ice water until it would seem that it would freeze, and yet apparently did not feel the cold as an ordinary man would feel it.

Case No. 2.

Age, 23; white; American; married 9 months.

Family history: Negative.

Previous history: Negative, never sick.

Patient's statement: He worked at trade 9 years, 6 years with the hammer, but never more than one year at a time. Would stop because of doctor's orders.

When he first began using the hammer a large bump on the back of the hand appeared as large as an egg, which lasted for two or three years; no evidence of this at this time. The fingers and outer half of hand are numb and dead on left hand; the thumb and first finger on right hand have same feeling.

Has pain in the elbows and shoulders all the time while he works. This pain continues, working and resting, while he is using the hammer. Has a pain and numbness in neck and pain in base of left hip. Arm hurts so badly he can not raise it. Has not worked for two months. Arm still hurts and hand is still numb. Awakes with hands and arms numb and "asleep" every night.

Has peculiar spots appear on body, which go away when he works at other work. Has three times been told to quit work to save his life. Loses weight (20 pounds) when he works. Always has a pain below ribs when raising hammer. Calf of legs and knees hurt when he works. Is so tired he can hardly drag home at night. Has worked five months in past year; farms between times. Still has the numbness, but not so much pain.

Physical examination: Reveals nothing wrong; slight, well-muscled physique, about 140 pounds in weight.

Neurological examination: Negative, except the deep tendon reflexes on left side diminished, and the numbness in hands. Has diminished pain, tactile, and temperature sense in hands, especially the left hand.

Electrical conductivity: 90 volts were used and apparently not felt on hands; very painful on wrists; 6 to 10 milliamperes were measured as passing through the hands, 20 to 25 milliamperes when the electrode was on the wrist. This condition was confirmed on four successive days' observation.

Case No. 3.

[Employee No. 1 (see p. 19).]

Age, 37; white; German; married.

Family history: Negative; no children.

Previous history: Negative; never sick.

Patient's statement: Has worked six years with the air hammer. Works seven months each year, eight hours a day, five and one-half days a week. Has pain in left arm, running up the arm to shoulder; has a feeling of pins and

needles in hands and arms. Fingers get white when cold. Pain is worse at night; hurts for three to five hours after work stops. Hands are numb and like dead hands in morning. Has numbness or changed sensation down left side, "pins and needles" in left foot. Very nervous and restless each evening. Has a precordial pain and thinks this is from pushing the tool.

Claims his hands swelled for four or five weeks after he began working and swell for a week or two when he first works after a lay-off. Pain is so severe he gets sick. When he lays off for five months his hands do not hurt all the time, but are always numb. Pain is not felt when he works, but begins when he quits in the evening. Hands feel as if he has velvet on them when he touches anything. Hands feel as if they do not belong to him, but are a thing separate from his body. Pain begins when he quits work, continues till he goes to sleep, then in morning hands feel numb. Has to put hands and arms in all positions to sleep; can only keep them in one position for about 15 minutes, when they pain him so much he must change the position, until at last he sleeps from exhaustion.

The only time he has pain when he is working is when he is cleaning a surface and holds his arms in a strained position for a long time. Then his arms pain and ache. At times when he is cleaning a hard surface he feels a sensation in his head as though his scalp were loose. He has to grit his teeth to keep at work.

Physical examination: Strong, well-nourished, hard-muscled man, apparently physically perfect.

Neurological examination: Negative, except diminished pain, temperature, and tactile sense in left hand.

Electrical conductivity: Much reduced in hands, much less in the left hand (90 volts used). On the left hand and fingers, 8 to 10 milliamperes were measured as passing; on the wrist, 20 milliamperes; on right hand, 11 to 12 milliamperes passed on the hand and fingers, 25 milliamperes on the wrist.

This case was carefully examined for four successive days and the observations confirmed by repeated examinations.

This is a case presenting both severe local effects and severe effects upon the general nervous system. The man had constantly before him the fear that he would go insane. With the amount of pain he constantly suffered and the loss of sleep caused by the pain and the added worry, there is danger that such a fate may befall him.

Case No. 4.

Age, 43; white; English; married.

Family history: Negative; has one child in good health.

Previous history: Is partially deaf from an injury; otherwise always well. Has worked 25 years at his trade and 2 years with the air hammer.

Patient's statement: His left arm, hands, and fingers feel as if they were in cold water; feel numb and dead. His hand seems as though it does not belong to him; he doesn't know it is there except when he looks at it; pains when cold, as if frostbitten. His sleep is not disturbed. His hand swells and pains when he is cleaning and using tool on flat surface; pains when he is "straight tooling." Feels worse at night; when hands are cold he can't pick up anything without looking at it; hands have no "feeling."

Physical examination: Negative; a strong, well-nourished, hard-muscled man.

Neurological examination: Negative, except diminished tactile, temperature, and pain sense in left hand.

Electrical conductivity: With 80 volts no sense of pain was experienced in the hands, but they were exceedingly painful on the wrists and elsewhere over body.

This case was examined but once.

Case No. 5.

Age, 51; white; American; married.

Family history: Had one brother who had epilepsy and one sister who died of paralysis at 53; has four children, all healthy.

Previous history: Negative.

Patient's statement: Has worked at trade 32 years. When he began working with the air hammer his hand and fingers got so he could not pick up a pencil. He was so awkward he could scarcely use them. After six weeks he could not work regularly. Has worked about one year altogether with many intervals. The tool makes the hand swell at first. Hand is numb and asleep. Has not worked with hammer since September, 1916. This examination was February 20, 1917; hand is still numb. Has quit work by advice of his physician. Says he was a nervous wreck. Lost weight, from 180 to 155 pounds. He could not sleep at night and felt as if his eyes were "pushed out." Would walk all night at this time; could not work more than half a day at a time.

Physical examination: Negative; a well-nourished, hard-muscled man.

Neurological examination: Negative, except in left arm and hand. Here there was diminished tactile, pain, and temperature sense.

Electrical conductivity: The sense of pain to strong electric currents was much diminished, but my notes do not show that I measured the electrical conductivity in this case.

In this case the local conditions were not so apparent as in the other cases, but the general nervous condition was much worse. Possibly because of a distinct heredity he was made so nervous from loss of sleep and general nervous irritability that had he continued to work with the hammer it is probable he would either have become insane or a victim of complete nervous prostration.

Case No. 6.

Age, 47; white; American; married.

Family history: Negative; has six children, all well and healthy.

Previous history: No serious illness except typhoid fever four years ago. Worked at trade 33 years; with hammer 16 years. Seven years' steady work in that time. Has not been working for past three weeks.

Patient's statement: His left hand is numb, especially on cold or damp days. Hand gets white when cold. He has no trouble except in left hand and arm. These hurt when cold, especially when "warming up." Although he said in a matter-of-fact way that his hands pained him when warming up, he also said that he fainted one week ago when his hands were "warming up." This fact shows the degree of pain he suffered, as a man does not faint from pain unless the pain is considerable.

He states his hands always pain him when working on a cold day, but do not pain him at other times. His work does not affect his sleeping.

Physical examination: Negative; a strong, well-muscled man.

Neurological examination: Normal, except in hand. There was numbness and diminished pain, temperature, and tactile sense.

Electrical conductivity: There was no response to electricity and no evidence of sensation until 85 volts were used. The comparative conductivity was not measured in this case, as I had only one opportunity to make an examination. Here was a man of iron nerves and stolid disposition. If he could not work with the air hammer it would be useless for anyone to try.

Case No. 7.

Age, 50; white; American; married.

Family history: Negative; has four children, all healthy.

Previous history: Negative. Has worked at trade 33 years and with the air hammer 3½ years.

Patient's statement: His arms and hands are numb and pain him—severe pains at times. Has lost 30 pounds since he began using the hammer. The pains began after five or eight months of use and affect the arms, hands, and stomach. Has frequent cramping and has burning urination. Can not sleep when he works. Has averaged three or four hours at night for the past six weeks. Is exceedingly nervous, restless, and irritable. Has had to quit work and go home on account of indigestion, vomiting, etc. The last attack of this character was three months ago, but has had frequent attacks.

Physical examination: Normal, except the blood pressure—systolic, 157; diastolic, 100.

Neurological examination: Negative, except diminished pain, tactile, and temperature sense on left hand.

Electrical conductivity: No sense of pain on hands when 80 volts were used, but marked pains when the electrodes were passed up to the wrists. On the left hand, 12 to 16 milliamperes were measured, while the same voltage gave 25 on the wrist; on the right hand the difference was 18 to 20, as against 25 milliamperes on the wrist.

He was examined successively once a week for several weeks. There was no difference in the examination except in the blood pressure, which was as follows:

February 21: Systolic, 157; diastolic, 100.

February 24: Systolic, 150; diastolic, 100.

March 3: Systolic, 150; diastolic, 100.

March 10: Systolic, 140; diastolic, 100.

During the first three weeks he was using the hammer and was not sleeping more than two or three hours at night and his blood pressure was too high.

On the last examination he was not using the hammer and was sleeping about six hours and his blood pressure was normal. This man will become an old man before his years if he continues to use the hammer.

The second physician, Dr. Francis M. Barnes, jr., of St. Louis, was requested to come to Bedford and examine, on behalf of the employers, some supposedly typical stonecutters. Seven men were selected by the employers and requested to go to the headquarters of the employers' association and permit this physician to examine them. Three men were brought to him by a surgeon of the United States Public Health Service, who selected them as interesting cases. Dr. Barnes made no attempt to discover cases of the ailment complained of in Bedford; his examination was confined to those who were brought to him, the majority of them by their own employers.

The fact that these men were so selected and that they were examined in the employers' headquarters by a physician brought in by the employers throws some doubt on the testimony given by them, testimony which the physician accepts without question.

INVESTIGATION INTO THE EFFECTS OF THE PNEUMATIC HAMMER ON THE PHYSICAL AND MENTAL HEALTH OF OPERATORS.

BY FRANCIS M. BARNES, JR., M. D., ST. LOUIS, MO.

Introduction.

The investigation upon which the following report is made was conducted in Bedford, Ind., December 27 to 30, inclusive, 1917. In its scope the investigation included an inspection of mills and a survey of the working environment, interviews with workmen using the pneumatic tool, and with the superintendents of mills, and detailed physical, neurological, and mental examinations of 10 subjects who had used the air hammer for a number of years.

The superintendents of two large mills were interviewed. Both of these men had been in the stonemasonry business for more than 20 years, beginning at the trade before the pneumatic hammer was introduced. Both had used the chisel and mallet in the early days, and one had had considerable experience, not only in personally working at his trade with the pneumatic hammer, but through having been in charge of the installation of pneumatic equipments in several large stone mills. In meeting with these men one is impressed that they are of that good, solid, more intelligent, honest grade of laborers who have reached their present positions of supervision with authority and trust because of their integrity and demonstrated ability to fill the place to which they have been promoted from the ranks. These men testify that they personally have been troubled with "white fingers" and "dead fingers" such as have been described in connection with the use of the pneumatic hammer, but that they had this trouble when using the chisel and mallet. According to their statement, the three fingers of the left hand, beginning with the little finger, were most affected. Neither of these men suffered any permanent damage, although one has also used the air hammer extensively, and at the present time their hands reveal nothing unusual in appearance and show no impairment in use. It is their opinion that the "white fingers" and "dead fingers" observed in stonemasons are more or less incident to the trade; that the hand which holds the chisel (the left) is usually and most severely affected; that this is largely, if not wholly, due to the cold and the cramping position of the fingers from the tight grip of the chisel and is not blamable directly either to the mallet or to the air hammer, excepting in part, especially where the latter is improperly used, i. e., in such a way that the exhaust is impeded and forced to discharge from the drill socket along the drill and thus bring a draft of cold, damp air onto the fingers with the consequent effect of the cold.

Selection of subjects and manner of examination.

In the selection of subjects for examination it was deemed advisable for comparative purposes to have representative groups, as an examination of every worker in this industry of this district was not feasible. Therefore, they were picked according to factors which were considered of importance, such as their age, their length of service at the trade of stonemason, the duration of the use

of the chisel and mallet as well as the air hammer, and according to the effects, or absence of them, which might be attributed directly to the use of the hammer under reference. In most instances the subjects were selected by the employer who was instructed only in general terms as to the type of man wanted. These men did not know until sent to the place of examination that they were to be so investigated, and came directly from their work without making preparation, excepting two or three. Three were selected through the aid of a surgeon from the Federal Bureau of Public Health, who had been detailed to investigate the air hammer in the stone industry. These three were commonly reputed to be among the most active of those workers who complained of the damage which they claimed resulted from the use of the air hammer under reference. To each subject it was explained that whatever information he might give was voluntary, that it would not be used (if at all) in connection with his name or in any way to act to his detriment.

It is obvious that such a selected representative group, very carefully and thoroughly examined from all viewpoints, would be likely to give more valuable information and trustworthy data from which accurate conclusions could be drawn than could a much larger group more incompletely and casually examined. From one and a half to two and a half hours were consumed with each subject in this study. These 10 workers represented four cut-stone companies of the district, excepting two who were not at the time employed. The information concerning the individual subject was given in each case by him just before the physical examination itself was made.

Following the interview the subject was shown to another room, asked to remove all clothing and get into bed. All tests were made with the subject in the recumbent position in bed, excepting where, from the very nature of the test, other postures were necessary, such for instance, as testing gait and station. Weights recorded do not include subject's clothing unless noted otherwise. Each case was examined in an orderly, systematic manner, carefully and repeatedly when necessary or otherwise advisable, and without haste or interruption. With the hot and cold sensory tests only moderately cold and moderately warm test tubes were used—neither hot or icy cold—neither extreme. Visual acuity was determined by the ability to count fingers at nine feet; visual field ascertained for the four quadrants but not charted; pupils and eyeballs were examined by the aid of an electric flash light and under a lens; ophthalmoscopic examination made with the Wappler electric instrument; hearing tested by conversational tones and tuning fork; sensation was investigated by the use of a needle, cotton, and tuning fork; blood pressure was determined with the Faught aneroid instrument and a stethoscope. The findings were recorded during or immediately at the conclusion of each examination. The examiner alone was present during the interview and while the subject was being questioned as to history and, also, during the examination, excepting in one instance when the above-mentioned surgeon from the Federal Bureau of Public Health was present during the physical examination.

Résumé of results of examinations.

These subjects were examined directly upon coming from their work; that is, within one-half to two hours, excepting two who were not employed at the time of the investigation.

Family history.—Four had history of tuberculosis, two alcohol, and two nervous disorder. No history of cancer, other constitutional, or mental disease.

Personal history.—The subjects examined were all males of the Caucasian race, in ages from 24 to 54 years. Their general past as well as present

health was good in every instance. All were robust, strong, well developed, and well nourished. In four there was a history of some "rheumatic" tendency. No history of nervous or mental disease, epilepsy, unconsciousness, or the like. Seven carried life insurance, in two this was not noted, one was not insured. None had ever been refused insurance or had their rate increased. One admitted gonorrhoeal infection and one both gonorrhoea and syphilis; otherwise venereal disease was denied. Eight of the 10 used tobacco for smoking or chewing or both. In 6 there was a history of alcoholism. All subjects were married, 7 had living and healthy children, and only 1 gave a history of the wife having miscarried or aborted. All reported a good appetite. One admitted constipation. One complained somewhat of sleep being disturbed. All 10 reported no recent loss in weight.

Occupational history.—The years during which these 10 subjects had worked at stonecutting ranged from 9 to 41, with an average of 22.5 years, only 3 having given up the trade for any length of time since first beginning; 1 for 1½ years while in the Army, 1 for 4 years while holding a civil position, and 1 for 12 years while working on a farm. These 10 subjects had used the air hammer at their trade from 3 to 22 years, averaging 9.3 years. All of them had worked with the chisel and mallet before using the air hammer. All had worked in limestone principally, though three had also worked with the air hammer in "hard" stone.

Concerning the troubles with their hands, nine reported "white fingers" while using the air hammer and four of eight questioned reported similar troubles while working with the chisel and mallet. Of the nine mentioned all had the trouble in their left hand, three in addition having had similar trouble in their right hand. Not one reported swollen fingers. Three subjects reported that the fingers also were painful or subject to paresthesias of nonpainful character. In only one subject was the condition of "white fingers" actually present and examined during this investigation. In four subjects there were reported disturbances in the arm and shoulder, two of the right side and two of the left. These disturbances were of the nature of stiffness or soreness with occasionally some pain, and were of the general character commonly known as "rheumatic." Five of the subjects expressed an opinion that the air hammer caused the trouble mentioned in the hands, though one of this five would rather continue with the hammer than give it up. In all, seven expressed themselves in favor of the continued use of the air hammer, only three complaining of the damage which they thought it did them. Only one subject thought the hammer itself was solely to blame for the condition in the hands; one thought the hammer was the principal cause; two thought it was due to the action of the hammer combined with the low temperature and the grip on the chisel; six believed the trouble entirely due to the cold and the grip on the chisel, attributing to the air hammer no part in its causation.

Examination.—In no subject were there any evidences of neurotic temperament or mental disorder. Injuries bearing on the health in general or the nervous system were not present. No disease of the organs of the chest and abdomen was found. No glandular enlargements. Pulse was normal, a slight degree of arteriosclerosis being present in two or three subjects, but no more than to be expected at their age. The blood pressure was within normal limits, if anything somewhat lower than the average normal, but in no subject increased.

Cranial nerves: In two subjects irregularity of outline of one pupil was noted; in one there was slight impairment of hearing on one side; otherwise the cranial nerves were all negative.

Sensation: In nine subjects, aside from the hands, sensation was normal. In one there was reported some dulling below the elbows and below the knees on both sides, but this was not constant or definite.

Motor system: Four subjects showed a fine rapid tremor of the hands. One complained of tenderness over the calf muscles and in the right shoulder. Otherwise the motor system was normal.

Reflexes: The reflexes in eight subjects were all normal. In one the abdominals were absent. In one, reduced reflexes, suggesting locomotor ataxia, were observed.

Hands: In only one subject was the condition of "white fingers" observed. In all others the hands were somewhat reddened and flushed, but no more than might reasonably be expected to be found in outdoor laborers. The hands were calloused to a varying degree in different subjects, but in all quite extensively. The palm and certain of the fingers of the left hand were more calloused than the right. There was no actual cyanosis, excepting in one subject where this was slight. No swelling, no tenderness, no pain, no edema, and no involvement of the muscles or joints. Paresthesia was absent, excepting in one subject, who reported some numbness in his "white fingers." Sensation for all tests was acute and practically normal. There was in most subjects a lowering of the acuteness of feeling, some blunting or dulling, but this certainly was no greater than could be expected in hands where there was so much callus present. In all but one subject the callus was sufficient explanation for any variation from the normal which could be observed in sensation. This subject, during the brief period of time that the "white fingers" were present, did present some sensory impairment, but it is considered that this was due entirely to the low temperature, coldness of the hands depending upon vasomotor, and not especially nervous, disequilibrium.

Interpretation of findings.

The condition observed in the hands of some stonecutters is not one corresponding to any disease known to medicine. The fact that such a condition, as is here under reference, has not been described in medical literature is, in itself, most highly significant. Whereas the stonecutter has been working at his trade for centuries and the pneumatic hammer has been used in this trade for more than two decades, this condition of the stonecutter's hands has only been brought to attention within the past two years. If a specific disease of the stonecutter's hands existed it is inconceivable that it should have so long escaped the attention, not only of the medical profession, but of those interested in labor questions generally. That it is not due to the pneumatic hammer directly and primarily is proven by the fact that the condition was known to exist prior to the introduction of this tool. That the air hammer may have added somewhat to the frequency of its occurrence, as compared with the period when the chisel and mallet were used exclusively, is possible, but not proven. An extensive comparative study, which circumstances naturally made impossible, could alone settle this question. Again, the fact that the trouble, when present, preeminently affects the left hand, which holds the chisel and not the hammer, indicates clearly that other factors than the hammer itself are of more signal importance in its causation. The cramped position of the chisel hand with the more or less continuously maintained contraction of the muscles is one of these important factors. However, the hammer or the grip on the chisel, either alone or combined, are not sufficient to produce the condition as is proven by the fact that it does not occur in the warmer seasons of the year when the stonecutting industry is at its height.

Therefore we have left the factor of low temperature, which seems to be the final and most important factor in the production of those vascular changes seen in the hands of some stonecutters, which, although physiological in nature, form the pathological basis for the occurrence of stonecutters' "white fingers" and "dead fingers."

So far as can be ascertained the condition leads to no permanent disability and results in no organic disease. Why it is that only a portion of stonecutters are affected can not be answered. Whether certain undetermined conditions of poor general health or specific diseased conditions existing, but not recognized, predisposes certain stonecutters to this disturbance is not evident from this investigation, although apparently such is not the case. It is a generally accepted fact that stonecutters, as a class, show a high mortality rate for tuberculosis. This is true for sandstone workers (76.5 per cent of deaths), but not so for workers in limestone (7.5 per cent of deaths). On the contrary, working in limestone has been recommended as advantageous to those with the tubercular predisposition. The use of alcohol among stonecutters is rather generally acknowledged to be prevalent, but its bearing upon the condition here investigated does not loom large. Although the small number of workers examined in this investigation does not permit of extended conclusions, it at least appears apparent that the general health of these men is, as a rule, good. With one or two exceptions they were all well-developed, robust men without demonstrable general physical or mental disease.

Conclusions.

Conclusions drawn from a comparatively small series of observations must naturally be subject to some limitations. However, the uniformity of the results of the examinations made in this investigation, taken together with the testimony of the workmen and of others, reasonably justifies the following deductions:

1. Stonecutters working in limestone, as a class, enjoy good general health and are not, because of their trade, especially susceptible to any particular disease.

2. Stonecutters are liable to a disorder affecting the hands, particularly the left hand.

3. This disorder of the hands is of a vascular character, not due to organic changes in the circulatory system, but dependent upon vasomotor reactions.

4. These reactions are physiological in character and are occasioned by three factors incident to the work of stonecutting. These are: (a) Mechanical irritation of the skin, (b) continued muscular contraction of a cramping nature, (c) low temperature, cold.

5. Of these three factors, cold is considered the most important because, (a) the condition only occurs during very cold weather and never in the summer, (b) warmth and measures to restore the circulation (rubbing, swinging the arms and the like) cause its disappearance.

6. It can not be caused by the air hammer alone because, (a) it occurs in those who have not used the air hammer, (b) it does not occur in warm weather when the stonecutting industry is at its height and, therefore, when the air hammer is most in use, (c) it occurs mostly in the left hand and not the right hand in which the hammer is held.

7. This vasomotor disorder is of temporary duration and is not known to have resulted in permanent disability of the hand nor itself to have been the cause of development of any other local or constitutional disease.

8. It is probable that once having occurred, the person is rendered more susceptible to its reappearance just as is the one who has had his ears or fingers frostbitten or "nipped" by the cold more susceptible in these parts to the subsequent exposure to cold. This explains the occurrence of "white fingers" in stonecutters when not actually engaged at cutting but otherwise exposed to low temperatures.

9. There is no sufficient reason in the signs and symptoms presented in this disorder to conclude that one has to do with Raynaud's disease, acroparesthesia, neuritis, or an occupational neurosis.

10. The institution of measures to warm the chisel before and while using, the wearing of gloves, and the discontinuance of the prevalent custom of blocking the exhaust outlet and thus forcing a draft of chilled air out along the chisel and onto the fingers of the left hand would do much toward the prevention of this trouble.

The reports of the third and fourth physicians are concerned with results of the use of the air hammer in the marble industry. Both reports were made at the instance of employers in the industry.

EFFECT OF PNEUMATIC TOOLS ON MARBLE WORKERS.

BY THOMAS H. HACK, M. D., PROCTOR, VT.

Herewith I submit report of my examination relative to the use of the air tool in the marble industry. In the building shop of the Vermont Marble Co., at Proctor, Vt., there are in all 46 marble cutters who use the air tool. About four weeks ago [this statement was made Feb. 28, 1918] I personally examined 45 of them. One man was out of town but he was known to be free from any disability whatever. The ages of the men vary from 26 to 56, the average being slightly over 41. They had used the air tool steadily from 3 to 23 years, the average number of years being almost 14.

The examination was made topically, with the following results:

1. The question was asked "What local symptoms do you complain of?"

Nine had no symptoms, 34 the usual symptoms, and 3 unusual symptoms. The usual symptoms, as is generally known, consist of a slight degree of numbness in cold weather in the three middle fingers of the left hand. There is no pain at any time and the numbness lasts only a short while. There is no indication whatever of any serious or permanent injury from this cause; in fact, of these 34 men, 5 stated that they had the same numbness when using the old method of mallet and hammer.

Unusual symptoms are mentioned in three cases. One complained of pain in the precordial region after using tool for some time each day. The pain was relieved by pressure. There was no relation to the use of the air hammer. The second complained of a numbness in left arm coming on about 4 or 5 o'clock every morning. This man was in the hospital some 18 months ago suffering from a heart lesion. The third man complained of pain in the left hand and forearm after work. He was left-handed. He has had several attacks of muscular rheumatism.

2. Is there any swelling of the hand or fingers?

Forty-five showed none whatever.

3. Is there pain after stopping work?

"No," 41; "Yes," 4. Of these 4 cases 1 can be explained as rheumatism. The second complains of a numbness of left arm coming on about midnight

and lasting for a short time. The third complains of numbness of left hand at times, but part of his work consists of "roughing off" for carvers, which is done by the hammer and chisel and not with the air hammer. The fourth complains that left forearm aches every night. Since my examination this man has been in the woods chopping and he now complains of the same pain and in both arms.

4. Pain in other parts of the body?

"No," answered by 43. Two answered affirmatively. Both cases were found to rise from other causes than the use of hammer, one being a precordial pain and the other being due to muscular rheumatism.

5. Nervous symptoms?

Answered "No" by 45.

6. Do you consider your nerves affected in any way by the use of the air hammer?

Answered "No" by 45.

7. The sensations of touch, pain, and temperature were tested and it was found that they were normal.

Aside from this specific examination, I am in a position to testify as to the general health of these men who use the air tool. I have been practicing medicine and surgery in Proctor for 18 years and have served most of these men in a professional way during all the time that they have lived here and thus have had every opportunity to be posted on their general health and to become aware of any occupational diseases if any such should develop. I can testify that in my judgment the use of the air hammer in the marble industry is not responsible for any general injurious effects on the health of the workers.

A STUDY OF THE EFFECTS OF THE PNEUMATIC HAMMER UPON WORKERS IN THE MARBLE INDUSTRY.

BY ARTHUR P. HERRING, M. D., BALTIMORE, MD.

Marble cutters.

The facts set forth in this report are based upon a study of the men working in two of the largest marble plants in Baltimore and of the men employed in structural-iron work at one of the large shipbuilding yards adjoining Baltimore City. A total of 50 men were examined or interviewed regarding the effects of the use of the air hammer. The result of this investigation reveals the presence among a small percentage of the men of a condition which they term "white fingers." This was found to be purely a local affection of two or three fingers of the left hand and an effect of low temperature, which causes a contraction of the blood vessels of the fingers holding the chisel. Consequently there is present on a cold day a feeling of numbness and usually a blanching of the skin of the little, ring, and middle fingers of the left hand which disappears upon placing the hand in warm water or rubbing the fingers for a few minutes. This condition is present only during a cold spell, is present only in a minority of the workers, is purely a local affection, and is recoverable and preventable.

This work began during October, 1917, when frequent visits were made to the Hilgartner marble plant and the Evans marble plant, both located in South Baltimore. During the same month, the shipbuilding yard of the Riter-

Conolly Co. at Fairfield, Anne Arundel County, was visited and a number of the men using the pneumatic hammer were examined. A final visit was made to the marble plants during January, 1918, when the temperature was below freezing.

At the first visit a general inspection of the entire plant was made and the sanitary and hygienic conditions observed, as well as the varying character of the work done by the men. The plants were found to be well lighted and well ventilated and to be especially free from dust. The plants are steam heated and are kept at a comfortable temperature except, of course, in zero weather, such as was experienced recently. Every man using the air hammer was observed and interviewed while at work and came later to the examiner in a private room in the plant for a thorough physical and mental examination.

The men who complained of cold or numb fingers were given an examination which included a review of their family, past and present history, a physical examination of the thoracic and abdominal viscera, testing the superficial and deep reflexes. Sensory tests as to pain, touch, and temperature were carefully made. The muscular system as to tremor, strength, and coordination of the muscles was recorded. Pupillary reactions, visual acuity, and any changes in the eye grounds were noted. The men spoke freely concerning their condition and cooperated in every way.

The examinations in October were made while the weather was mild, and at that time none of the men was being troubled with cold fingers. They would simply relate the experiences they had had in the past. In January, 1918, another interview was had with the same men when the temperature was below freezing, and they were working with the air hammer in a heated mill. This visit was made about 9 a. m., and none of the men had at that time cold, numb, or white fingers. Some had had the condition early that morning and a few others were affected only after work in the evening, but without exception it was found not to affect any of the men while working.

In one group of marbleworkers examined [cases 1 to 13], whose ages range from 22 to 53 years and who have worked at their trade from 7 to 35 years and have used the air hammer daily for periods varying from 7 to 25 years, no serious effects, other than having two or three fingers of one hand (usually the left) feel numb and cold for a short time during very cold weather, have resulted. This condition is transitory, purely local, and leaves no aftereffects, and is not associated with pain or weakness of the part, nor does it in any way interfere with the efficiency of the individual. Furthermore, it occurs in less than one-third of the men employed in the trade using the air hammer, and it certainly can not be considered to be a serious condition or one which in any way is injurious to the mental or physical health of the individual.

Another group of men [cases 14 to 35] had used the air hammer for periods ranging from 4 to 25 years without feeling any ill effects or complaining of their fingers being numb, cold, or white. Each of these men was seen and talked to in person.

AGE, LENGTH OF TIME AT TRADE, AND NUMBER OF YEARS' USE OF AIR HAMMER OF MARBLEWORKERS WHO DO AND DO NOT COMPLAIN OF COLD AND NUMB FINGERS DURING COLD WEATHER WHEN USING THE AIR HAMMER.

Men who complain.				Men who do not complain.				
Case No.	Age.	Number of years at trade.	Number of years' use of air hammer.	Nature of complaint.	Case No.	Age.	Number of years at trade.	Number of years' use of air hammer.
1	53	35	25	Three fingers of left hand and index finger of right numb and cold.	14	65	40	25
2	47	33	25	Three fingers of left hand numb in cold weather.	15	65	40	19
3	43	28	24	Three fingers of left hand numb and white in cold weather.	16	59	40	20
4	47	25	22	Two fingers of right hand numb and cold in cold weather.	17	53	35	25
5	58	40	16	Left hand numb.	18	47	35	25
6	52	35	15	Three fingers of left hand numb in cold weather.	19	49	32	22
7	41	25	12	Two fingers of left hand numb and white in cold weather. Treated by doctor.	20	52	30	25
8	34	22	12	Three fingers of left hand numb and white in cold weather.	21	51	30	16
9	36	15	12	White fingers on left hand. Uses alcohol to excess.	22	45	30	15
10	32	15	10	Two fingers of right hand numb and cold in cold weather.	23	54	28	20
11	22	7	7	Middle finger of right hand cold and white in cold weather.	24	43	27	14
12	50	30	20	Four fingers of left hand cold and numb in very cold weather.	25	47	25	20
13	31	12	11	Three fingers cold and numb.	26	39	25	22
					27	41	20	14
					28	36	20	12
					29	43	20	10
					30	30	16	8
					31	29	15	7
					32	29	8	8
					33	25	7	7
					34	24	6	6
					35	19	6	4

Structural-iron workers.

The men who were examined were working on a large steel oil barge, and were using the air hammer eight hours daily out in the open. These men usually wear gloves while at work. Of the 15 calkers and chippers, only three were found who complained of cold or numb fingers. The condition was transitory and never interfered with their work.

The riveters, who frequently have to work in strained and uncomfortable positions, had no trouble with cold fingers, but at times complained of stiffness of the muscles of the arm and shoulders from the unnatural positions they had to assume while at work. These men are exposed to more hardships than marble workers and use a much larger and heavier hammer, receiving more vibration from the hammer, but no serious effects were found.

Conclusions.

1. The most striking fact is that, although the air hammer has been used for the past 25 years in various industries, such as marble, limestone, granite, and structural-iron work in all of its various branches, not a single case has been reported in medical literature regarding the ill-effects of its use. Nor is there any mention made of the condition which the few men affected term "white fingers."

2. It would not have been possible for a definite disease entity to have escaped the observation, or failed to have been recorded by medical authorities for nearly a quarter of a century, if such a disease had existed.

3. The large group of men examined were found to be in very good health, indicating that there is nothing in their trade or surroundings which makes them subject to disease or lessens their efficiency in any way.

4. The group of 13 men out of over 50 examined, who complained of the so-called "white fingers" is a very small number, and further, not one of them has ever had to lose any time from his work on this account.

5. The condition which the men have termed "white fingers" is simply a reaction of the skin and underlying blood vessels to the stimulation of the cold, and is a physiological or natural result of the effect of low temperature on the skin.

6. The men examined have been using the air hammer from 6 to 26 years, most of them working daily, 8 hours a day and 6 days in the week without developing any disease which has caused them any serious inconvenience or permanent disability.

7. The comparison of the symptoms of the condition termed "white fingers" with other diseases which affect the skin and blood vessels of the fingers show very conclusively how dissimilar this condition is from those of a known character with well-defined symptoms.

8. Of the 50 cases examined, only 13 of the men had any complaint to make regarding the use of the air hammer. Practically all of the 13 cases were affected alike, that is, they stated that in very cold weather the three fingers (second, third, and fourth) on the left hand became cold, numb, and at times white. There was no pain at any time. This condition is not present as a rule during working hours, but comes on in the evening after work and is present in the early morning, if the weather is cold. The numbness disappears after a few moments when the fingers are rubbed or dipped in water. It never interferes with their ability to work and is present only during cold weather. Usually only the tips of the three fingers are numb; in a few cases the fingers are cold as far back as the second joint. In no case was the entire hand affected. There is no cramp of the muscles, nor is there any tremor or weakness of the hand or arm.

9. The condition known as "white fingers" is not a disease, has no pathological foundation, produces no disturbance of function of the part affected, and is to be classed simply as a local reaction of the blood vessels of the fingers to the cold.

The physiological "white fingers" are better understood when we compare them to several pathological conditions which appear somewhat similar, but entirely dissimilar when carefully analyzed. The differential diagnosis table of related conditions is appended.

Neuritis is a pathological condition due to an inflammation of the nerves, caused by an injury, occupation, or some poison, such as alcohol, lead, etc. The symptoms vary according to the causes which produce the inflammation. In general, there is pain and tenderness along the course of the nerve, paresthesia, and loss of sensation, with finally paralysis of the part.

An occupational neurosis is a disturbance of the muscular movements caused by overuse and fatigue, which manifests itself in pain, tremor, weakness or cramp of the group of muscles involved. There is loss of function, but no complete paralysis, as a rule. A partial list of occupational neuroses is as follows: Writers' cramp, telegraphers' cramp, seamstress' cramp, shoemakers' cramp, money-counters' cramp, musicians' cramp, masons' cramp, blacksmiths' cramp, and watchmakers' cramp.

COMPARATIVE DIAGNOSIS OF NEURITIS, OCCUPATIONAL NEUROSIS, CHILBLAIN, AND "WHITE FINGERS."

[For definitions of neuritis and occupational neurosis see preceding text statement.]

Neuritis.	Occupational neurosis.	Chilblain.	"White fingers."
Usually symmetrical.	Not symmetrical as a rule.		Not symmetrical as a rule.
More frequent among men, depending upon occupation and use of alcohol.	More frequent among neurotic persons.	Caused by exposure to dry cold or even to cold, damp air, with sudden increase of temperature caused by going close to the fire.	Occurs among men who use steel chisel during cold weather, on marble, granite, or structural-iron work.
Attacks the nerves of the feet and hands and extends up the limbs.	Develops gradually and affects the muscles used in a particular occupation.	May affect any exposed part of the body, i. e., nose, ears, fingers, or toes.	Affects only the fingers of the left hand.
Severe pain along course of nerve.	Some pain and stiffness or cramp of muscles. No pain along course of nerve.	If severe, there is pain.	Not accompanied by pain, redness, or swelling.
Signs of inflammation.	No signs of inflammation.	Part gets red, swollen and hot, and itches. May break down into ulcers.	Not accompanied by pain, redness, or swelling.
Sensory changes.	No sensory changes.		No sensory changes of a permanent character. No change in the nerves or blood vessels of a permanent character.
Weakness of arms or legs; finally paralysis.	No paralysis of part. Recovery usually good.	Recovery usually good; recurrence on exposure to cold.	No muscular weakness, tremor, or cramp of muscles. Numbness and paleness of fingers relieved by rubbing or placing part in warm water. Recovery during warm weather; recurrence during cold weather.

A vasomotor trophic neurosis is a pathological condition in which there is a disturbance of the vasomotor nerves associated with trophic or nutritional changes, accompanied by sensory changes, i. e., pain, paresthesia, and gangrene of the part, with consequent loss of function.

COMPARATIVE DIAGNOSIS OF VASOMOTOR TROPHIC NEUROSES AND "WHITE FINGERS."

[For definition of vasomotor trophic neurosis see preceding text statement.]

Raynaud's disease.	Aeroparesthesia.	Erythromelalgia.	Scleroderma.	"White fingers."
Symmetrical gangrene.	Symmetrical in character.	Symmetrical in character.	Usually bilateral in character.	In majority of cases affects only the fingers of one hand (usually the left).
Not a common disease.	Not frequent except among washer-women.	Not a frequent disease.	An infrequent disease.	
Occurs in neurotic persons.	Neurotic persons specially liable.			
More frequent among women and children.	More frequent among women over 30 years of age.	Occurs in either sex.	Occurs especially in adult women.	
Attacks extremities, usually fingers, toes, etc.	Tips of fingers usually affected.	Rarely affects the hands.	Affects face, chest, arms.	Tips of fingers get cold, pale, and numb. Does not extend up the hand or arm.
Not caused by occupation or changes in temperature.	Not affected by temperature.			Is present only during very cold weather.

COMPARATIVE DIAGNOSIS OF VASOMOTOR TROPHIC NEUROSES AND "WHITE FINGERS."—Concluded.

Raynaud's disease.	Acroparesthesia.	Erythromelalgia.	Scleroderma.	"White fingers."
Paroxysmal. Severe pain precedes the attack, parts are numb, pale, and waxy. A blue-red discoloration of skin on symmetrical parts, often followed by gangrene. Mental symptoms of depression and gastric disorders often occur.	Pains in fingers very severe, with numbness and pallor. Pallor of fingers and hands. No discoloration. No gangrene.	Begins with burning pains and reddening of the skin on the distal part of the feet. Skin is red and swollen.	Pain, numbness, and a feeling of tenseness are present. Pain not severe. Skin becomes hard and tense. Has a glass-like appearance.	No pain. No swelling. No redness of skin. Skin is shrunken, but not hard.
Movements of the affected parts are hampered.	Paresthesia and pain.	Pain is "as if living fire were under the skin." A recumbent position and cold relieve the pain, while it is made worse by walking and warmth. It is worse in summer.	Sensory changes not marked.	No sensory changes. Exercise and warmth relieve condition.
	Condition is usually chronic, but life not endangered.	Extends over many years with remissions.		No weakness or paralysis.

APPENDIX A.—EFFECT OF AIR HAMMER ON HANDS OF GRANITE CUTTERS.

In order to secure information concerning the alleged occurrence of the affection, the following letter was sent to Mr. James Duncan, international president of the Granite Cutters' Association:

JANUARY 15, 1918.

MR. JAMES DUNCAN,
*International President, Granite Workers'
International Association of America.*

DEAR SIR: This bureau is having a special investigation made into the effect of the use of the pneumatic chisel on the health of stonecutters in the Indiana oolitic limestone belt. Dr. Alice Hamilton, who is making this investigation, writes me that "the employers insist that granite workers use the air hammer as much as do limestone cutters and yet never have dead fingers, but the men say neither statement is true. Granite cutters, according to them, do not use the hammer nearly so continually and they also say that in Quincy, Mass., four granite cutters were recently rejected by the exemption board because of such a condition of the hands." Have you information on this matter? If so, will you kindly send such information to me at your very earliest convenience? I would be greatly indebted to you for any data that you can secure for me in regard to the effect of the use of pneumatic tools on the health of granite cutters.

With anticipated thanks for your courtesy,
I am, very truly yours,

ROYAL MEEKER,
Commissioner of Labor Statistics.

To this communication Mr. Duncan replied as follows:

QUINCY, MASS., *January 28, 1918.*

DEAR SIR: In reply to your letter of January 15, will say that the employers who told Dr. Alice Hamilton, who had been investigating the effect of the use of the pneumatic chisel on the health of soft-stone cutters in the Indiana oolitic

Limestone belt, that granite cutters use the air hammer as much as limestone cutters and yet never have dead fingers, stated to her what they knew to be not only a misleading but a false statement.

The statement is true that granite cutters use the pneumatic chisel as much as do limestone or soft-stone cutters, perhaps more so, for the harder the material the more justification there would be for the use of the pneumatic or any improved tool. The pneumatic machine is used so much in the granite cutting trade at the present time that workmen who have entered the trade in recent years and who are known as finishers—that is to say, men who perform the neatest and best part of the work, in fact all of it after a stone has been squared up or polished—scarcely have the use of the old hand tools, and only middle-aged or elderly men in our trade who in entering it had nothing else but the hand tools are considered expert now in both the use of hand tools and in the use of the pneumatic tool.

Of course, any one who has used the tool for a number of years and who is of a somewhat nervous temperament and, therefore, is apt to hold the tool quite tightly in his hand in a very short time falls a victim to numb fingers, and quite a number of our members have been refused enlistment by examining boards because of having numb fingers principally of the left hand which they use to hold the tool. If a great amount of care is taken in acquiring the use of the tool and keeping it up afterwards by holding it somewhat loosely in one's hand, the strain and vibration do not then affect the nerves and hand tissue so much, but the pneumatic tool is so useful and can do work so much better and more quickly that men of my trade could not be induced at the present time to think of giving up the use of the tool. They and inventive men in tool making, etc., are all the time perfecting the use of the tool, which from time to time to some extent reduces the evil effects. It has recently been asserted, for instance, that if electricity instead of compressed air were used as it is used in some instances, the vibration would not be so great and the injury not so severe.

I think the evil effects of the use of this tool have been longer in evidence in the granite-cutting industry than among soft-stone cutters, because, as I have stated, I think the tool itself has been longer and more effectively in use owing to being better adapted to delicate and intricate work than the hand tools in producing artistic ornamentation, and in fact the convenience of this tool in granite ornamentation has been the cause, as was recently much mentioned in the press in connection with the Mary Baker Eddy Memorial of hard white granite cut in New York City and now erected in Mount Auburn, Cambridge, of making the hardest of granites yield to the neatest kind of ornamentation coequal to anything which can be done in cutting marble or limestone.

Writing upon the subject generally, and which is in line with the inquiry at the end of your letter, will say that we have no specific statistics upon the subject, and in as far as data are concerned, I may say that while men of my trade have put up with the pneumatic tool because of the beneficial trade result above referred to, they have no love for it as far as the effect upon the nerves and hands are concerned.

Following up what may have been beneficial in the use of this tool, manufacturers and granite-cutting tool makers proceeded to put into the granite-cutting sheds a tool known as a hand surfacer. This has reference to dressing surfaces by a pneumatic machine being held by hand on small surfaces and where the machine could, therefore, be easily moved from one place to another, producing a plain surface similar to that produced by the ordinary surfacing machine, which is a large, heavy machine used to dress plain surfaces. This hand machine had a very bad effect on workmen's hands, wrists, arms, and nerves, so much so that some men who held the tool quite tightly in the hand while it was running were known to jump right out of bed at nighttime and fall on the floor because of the condition of their nerves, and the one workman jolled the other by saying that the man affected "had the jumps." Not only was this tool deteriorating in that respect but it creates an enormous amount of fine dust, and as it could only be used where men were cutting granite in the ordinary fashion in the granite-cutting sheds instead of being put outdoors or segregated from hand workmen, the effect was injurious to the health, not only of the man running the hand surfacer but of all the men within quite a number of feet from where he was employed. A great deal of power was turned into the machine to make it dress surfaces equally and which added

to the discomfort of the men operating it. This high power made the tool jump and bump unless it was held down hard and fast on the surface of the stone, and which required great strain and power in the hands and shoulders of the man operating it. This process gave the hand surfer the nickname "bumper" and is, therefore, known throughout North America in our trade as the "bumper."

The men of our trade are not opposed to improved machinery, but in this instance they took a stand against the use of this machine because of the effect it had on men's hands and arms, and because of the great increase it caused in the percentage of men dying from tuberculosis. Therefore, we have had a section in all our collective agreements with employers for years which provides that "hand surfacers—so-called bumpers—are not to be used." This has practically driven the bumper out of the trade, and the only instances of its use are nonunion granite-cutting jobs where the workmen have not collective protection to take care of their health and their lives.

A word of explanation about the increase of tuberculosis will no doubt be of interest. Granite dust per se is not unhealthy, for throughout the world where granite is cut where those pneumatic tools and machines are not in use tuberculosis is as much unknown as could be found in any occupation. This hand surfer, in place of giving off the waste in granite cutting in chips or small spalls, as is done with ordinary hand tools, ground off the waste very fine. Quartz or silica, being the leading component part of granite was, therefore, plentiful in the dust, and when ground fine is exceedingly sharp, and when breathed either through the nostrils or through the mouth slightly adheres to the walls of the bronchial tubes instead of passing on as does the softer dust. This causes a slight irritation which, if not promptly and properly attended to, and unless the workman is in the very best physical condition, causes inflammation in the throat, and which being added to daily in small particles in time causes hoarseness, later on sore throat, still later a cough, and by and by the throat, bronchial tubes, and lungs are so affected that the worker dies about 45 years of age. While the so-called bumper was in use the percentage of deaths by tuberculosis in our trade rapidly rose, and since we have refused to use the tool because of its unhealthy condition tuberculosis is not increasing but has slightly decreased as the cause of the death of our members. Thus, you see, we have gone through a process connected with the use of tools of that kind which is yet unknown in the soft-stone industry. This is because many of the air tools we use in cutting granite can not be used profitably or at all in cutting soft stone. The sharp, crisp dust in the cutting of granite falls away from the tool as it is used, or, as we say, "the tool clears itself" in cutting granite, whereas the dust in soft stone would adhere to the cutting tools when plates or peens are bolted together, thus forming a sort of a clay-bound condition and which would prevent the tool from cutting.

Our trade association has also, through its trade agreements with employers, arranged that the large surfacing machines already referred to shall be placed apart from men using the hand tools or the ordinary pneumatic chisel so that they will not come in contact with the dust from the surfacing machines, and according to situation and location they require those machines to be placed 25 to 75 feet from the nearest place where granite cutters are employed with the ordinary tools of our trade. This relieves all the men excepting the one running the machine and who has some protection in that by his manipulation of the machine he contrives to throw the dust away from him instead of toward him; in all instances where it possibly can be done he will stand and operate the machine with his back to the wind because the wind will then blow the dust away from him.

In many instances we have been able to induce employers to attach what are called suction devices to those surfacing machines to draw the dust from the cutting tool and carry it away from where workmen are employed. This process is more healthful, but of course, more costly and it is difficult to get very many manufacturers to attach the suction device to those machines because of the cost. We have been successful in getting their sympathy and support especially where the employers had been granite cutters and knew the bad effects of dust, and by and by as inventions are produced a condition will be found in our trade whereby our members will very likely refuse to run a surfacing machine unless it is supplied with a dust removing suction device, and we will give all kinds of encouragement to that thought as soon as it is evident there is a practical dust-removing suction device available. Experi-

ments are going on which are encouraging, but the devices so far used are few in number and sometimes not entirely practical.

I could not do justice to the subject mentioned in your letter without going into these details, and hope that I have measured up to what you required in your important and very interesting inquiry.

Yours, respectfully,

JAMES DUNCAN,
International President.

**APPENDIX B.—MINUTES OF BEDFORD LOCAL OF JOURNEYMEN
STONE CUTTERS' ASSOCIATION OF NORTH AMERICA.**

Meeting of March 24, 1916.—Moved and carried that this local notify headquarters that after May 1, 1916, this branch refuses to use the air hammer, and have it put before the executive board for an early decision.

Meeting of September 8, 1916.—Report of conference committee on proposed agreement accepted and committee given a vote of thanks. Moved and carried that the committee representing the Bedford branch to the Belt Conference stand with the representatives of the locals in the Oolitic Belt Conferences on the proposed agreement [doing away with the air hammer].

Meeting of January 12, 1917.—Accepted report of Belt Conference committee—rate 67½ cents and question concerning the use of the air hammer to be taken up by the executive boards of contractors and stonecutters.

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