[Official Report—As Approved by Committee on Publication.—Continued from Page 312.]

THE FIFTH ANNUAL MEETING, AMERICAN GAS INSTITUTE.

Held in New York City, October 19th to 21st (Inclusive), 1910

Second Day—Afternoon Session.

PNEUMATIC CAULKING WITH LEAD WOOL OF 30, 36 AND 48-INCH MAINS—*Continued.*

We finally placed an order for one of the Abenaque-Ingersoll-Rand type (No. 1 on the table) and one National Brake and Electric Company outfit (No. 6 on the table). The Abenaque-Ingersoll outfit is shown in Fig. 3, and the National Brake and Electric in Fig. 4. It will be noted that these two outfits are radically different, our idea being to try out both types and adopt the more successful of the two for future installations. The hammer adopted was the Ingersoll-Rand "Crown," chipping hammer, having a piston stroke of 3 inches. With a gang of 8 caulkers working it is necessary to have 10 of these tools. Then, if a caulker has any difficulty with his hammer he is given one of the spare tools and the trouble, usually nothing serious, can be remedied by either the foreman caulker or the compressor engineer. Fig. 5 shows two of these hammer and some of the experimental tools, the three on the right hand side being those finally adopted.

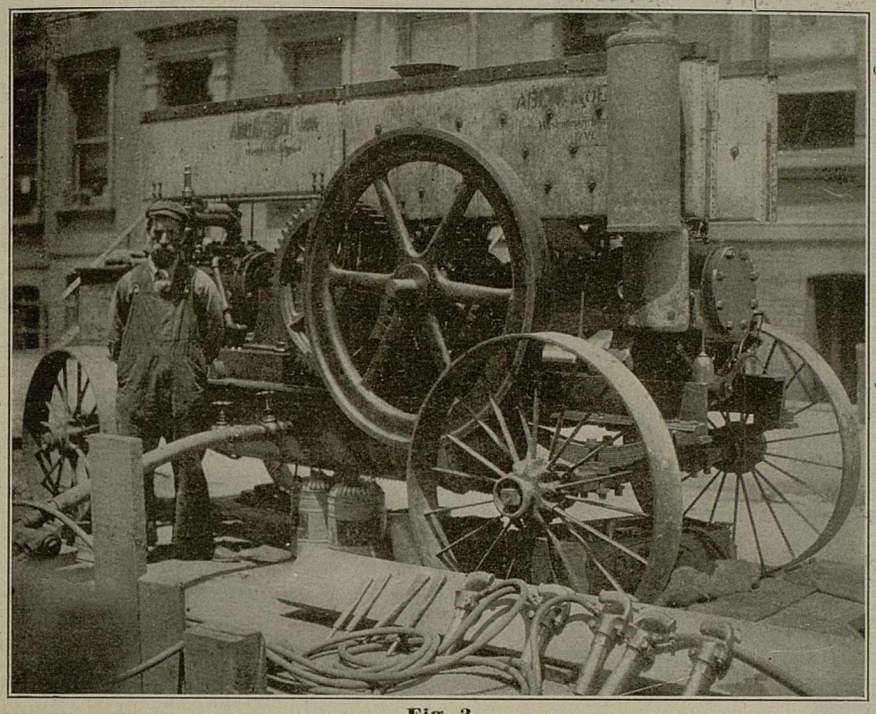

Fig. 3.

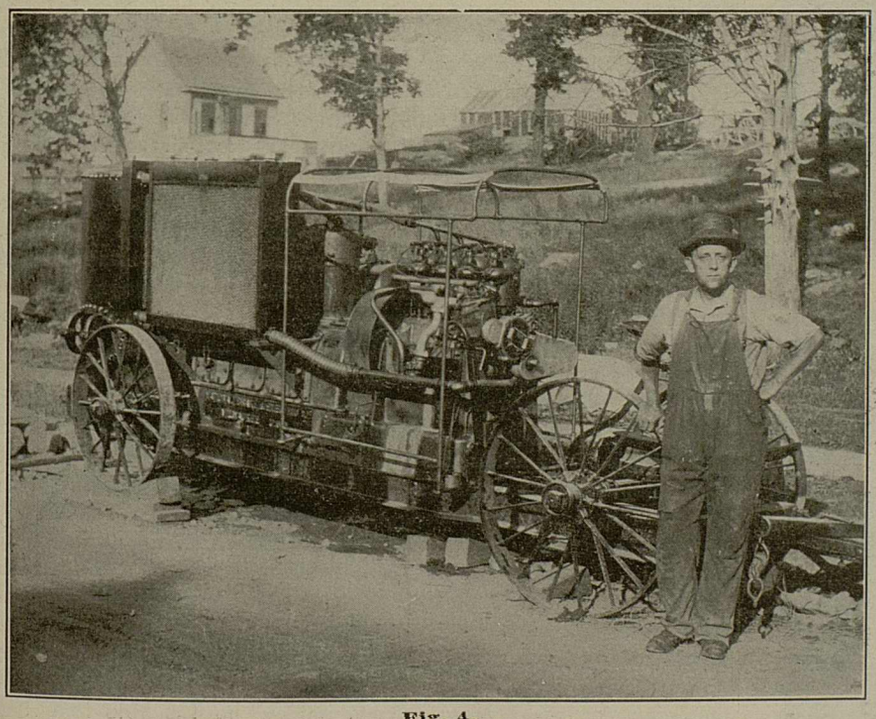

Fig. 4.

We had some little trouble at first with these hammers, due no doubt to the lack of experience on the part of the men handling them. The barrels became loose after working for an hour or so, allowing some of the air to escape, and several of the handle bolts snapped off. We were unable to find the reason for this ourselves and complained to the manufacturer. An expert was sent up on the work from the factory to investigate, and reported as follows:

"I found four hammers at work on the job, all with loose handles, which, from watching the operators, I am satisfied was caused by failure of the men to hold the hammers up hard against the tool while working. This caused the piston to strike the front end of the hammer, which resulted in the shock being transferred to the thread on cylinder and handle, thus causing an expansion of the handle.

"Relative to the breakage of bolts, I removed the bolts that were in the hammer and replaced them with nickel-steel bolts, brought by me from the shop for this purpose, and by placing the lock washer under the head of the bolt instead of under the nut, I found that it gave the desired results; *i. e.*, a tight handle, as, after watching the tools for 3 hours longer in actual service, I found that none of the handles come loose.

"The split handle complained of was the result of the same cause, inasmuch as the constant jarring had split the handle and the constant tightening of the bolt under the split handle caused it to spread. I would recommend that these broken handles be replaced and will endeavor, on future orders for this Company, to supply the handle bolts of the kind I have used with lock washers under head and nut."

Very little difficulty of this kind has since been experienced with the hammers. Their work has been quite satisfactory and the troubles we do have can generally be traced back to a green or inexperienced caulker. The yarning and caulking sets were forged by our own blacksmith, from a special 1 inch octagonal steel tool blank 11 inches long. Fig. 1 shows the shape and dimensions of the tools used on the different sizes of pipe. These tools are the product of quite some experimenting with different shapes and sizes, and give excellent results. As different joints of any size of pipe vary considerably in width, it is necessary to have several caulking sets with different thicknesses of face to meet these conditions. The broad-faced finishing tool is only used in facing off the last strand of lead wool.

Where it was possible to place the compressor alongside the trench near the joints to be caulked, the tool hoses were all run from a manifold tee. This manifold was in turn connected to the air receiver by a 3-inch rubber hose. That plan is much more satisfactory than running a long, wrought iron pipe line, the friction and air leakage losses being reduced to a minimum. Of course, there were cases where it was impossible for the compressor to stand alongside the trench, and the wrought iron line consequently had to be run. Figs. 6 and 7 give a very good idea of the manifold and rubber hose connections.

The first gang of compressed air caulkers was started on a 48 inch line. The men were allowed to go along slowly at first, until they became accustomed to the work, and no cost figures were kept for 2 or 3 weeks. A certain amount of trouble was anticipated at the start, as men of this class are naturally opposed to anything tending to reduce hand labor and will try in their own quiet way to do what they can to "Beat the game," and they did, for a short time.

As first organized, the gang consisted of 9 caulkers, 8 of them working in pairs, 1 acting as foreman, his duties being to assign the men to their joints and to inspect the finished work. There were also 2 laborers rolling the lead wool for the caulkers and a compressor engineer. After several weeks' work with this organization, a cost report (given in detail below) was turned in. This report covered the last 3 days only of the third week's work:

[1]Number of joints yarned and caulked	19
Caulkers, at 30 cents per hour	$91.00

1. All yarning done by hand.

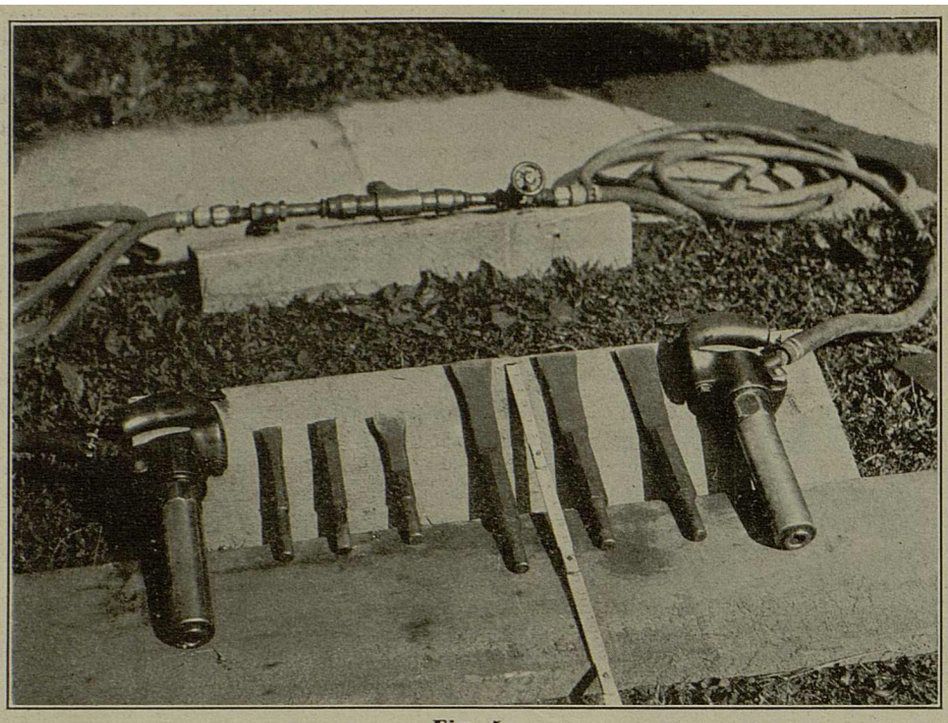

Fig. 5.

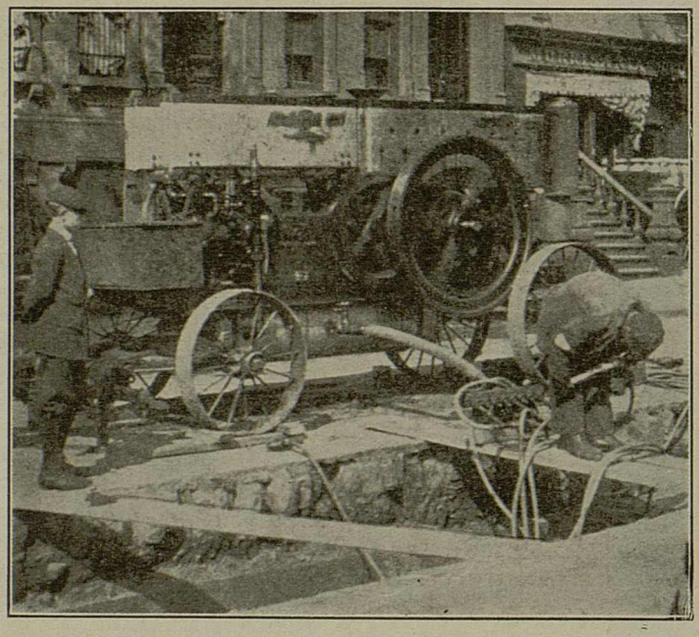

Fig. 6.

Fig. 7.

Laborers, rolling lead wool at 19 cents per hour..	$11.40
Compressor engineer at 30 cents per hour.....	9.00
Total labor cost.....	$110.40
Gasoline, 29 gallons at 1 cents.....	$3.19
Lubricating oil, ½ gallon at 50 cents.....	.25
Repairs and renewals.....	
Total cost.....	$113.84
Cost per joint.....	5.99
Average time taken to yarn and caulk joint.....	6 hours.

To this figure must be added a depreciation charge, on the plant in use, of about 30 cents per joint. This is, of course, a very hard figure to determine absolutely. If we take the cost of the plant complete as $1,900, and figure that it will last for 6 years, and average 1,000 joints per year, the depreciation cost per joint will be as stated above. Adding this 30 cents, gives us a total cost per joint of $6.29. To complete 19 joints in 3 days by hand, would mean a gang of 12 caulkers and a foreman, with some overtime. The cost per joint would figure as follows:

380 hours caulkers at 30 cents.....	$114.00
60 hours laborers rolling lead wool at 19 cents.....	11.40
32 hours foreman at 30 cents.....	9.60
Total cost.....	$135.00
Cost per joint (hand).....	$7.11
Cost per joint (air).....	6.29
Saving air over hand, per joint.....	.82

While there was an actual saving of 82 cents per joint, it was nothing like the result we had expected, and it was decided to observe the work more carefully to see whether it was not possible to cut the cost still further. A little personal investigation developed the following points:

The foreman being a caulker himself, and naturally in sympathy with his men and their desire to "beat the game," was making no attempt to push the work and had finally established a rule that 1 hammer to each pair of caulkers was all that was necessary. Consequently, one man remained idle while the other caulked his side of the joint.

The men rolling lead wool worked fast enough only to keep the caulkers supplied and stopped whenever there was no caulking going on. As a matter of fact, 1 able-bodied boy could have rolled in a day enough wool to keep the gang supplied for a week. Then the yarning was being done by hand, making the cost of yarning a joint actually greater than that of caulking it.

It was quite apparent that the whole proposition was one of system. Pneumatic caulking is much quicker and easier than hand work. Keep the caulkers busy all the time, with their work laid out intelligently in advance; have the tools, yarn and lead always at hand, so that it is unnecessary for a man to leave the trench, and the result will be a considerable saving both in money and time.

As a result of this investigation, the force was reorganized according to the following scheme: A foreman, not "one of the gang," was placed in entire charge of the caulking and given to understand that his job depended on his ability to push the men and reduce the time per joint. He was furnished with blank reports, and instructed to forward one properly filled out each night to the main office. This report served two purposes: It allowed the work to be followed very closely by the interested parties at headquarters, and also caused the men themselves to brace up, knowing that their individual results were being watched. We were also able to keep better informed about the compressors and tools, and to compare the result obtained with different types. The report was, of course, checked up by the field engineer before being turned in, and he was able to tell at a glance whether any time was being wasted.

It was decided at this time to yarn all joints by air. This proved quite successful, the yarning time being cut from 2 hours 15 minutes to as low as 30 minutes. The lead rolling force was cut to 1 man, who was sent away from the work to the storeroom and kept busy whether the caulkers were working or not. Still another improvement was made by providing the gang with a laborer acting as a tool man. Quite a lot of time had formerly been wasted by the men in running around looking for tools. The average caulker, when looking for anything, with the possible exception of a fight, has about as hard a time finding it as our well-known friend Diogenes. When

tools were needed it was up to the tool man to provide them, enough spare hammers being kept in reserve to immediately replace any needing repairs or adjustment. The caulkers were under no circumstances allowed to leave the trench during working hours. With these changes, the gang made a fresh start and the results shown by the next cost report turned in were more than gratifying.

The conditions under which the work covered by this report was done were unusually severe. The joints were all in a loose-rock trench, running through very low ground, the presence of salt water making it impossible to caulk at high tide. The cost per joint would naturally be higher under these conditions, for a certain amount of time were lost in shifting the whole gang to another part of the work when driven out by the water. The greater speed possible with pneumatic caulking was especially valuable to us here, as we were able to complete a whole joint between tides instead of having to leave it when partly completed, then come back next day to clean out the mud before being able to continue.

Following is an abstract from the cost report:

Total number of joints yarned and caulked	39
All labor charges (caulkers, foreman, toolman, leadman and compressor engineer)	$189.46
Gasoline, oil and repairs	5.44
Total cost, 39 joints	$194.90
Cost per joint	5 00
Plus depreciation on plant, per joint	0.30
Total cost per joint	$5.30

This cost would undoubtedly have been lower still, but for the fact that half of our hammers had been sent to the Ingersoll-Rand repair shop to be fitted with lock nuts and washers, as recommended by their expert. It would not be quite fair to compare this cost per joint with the cost of hand caulking in a dry trench. If it requires 10 hours for 2 men to yarn and caulk a 48-inch joint under normal conditions, it would certainly take 12 hours to do the same amount of work in a tidewater trench. On this basis, the cost per joint would have been as follows:

Two caulkers, 12 hours each at 30 cents per hour	$7.20
Labor rolling lead (per joint)	0.30
Foreman caulker (per joint)	0.40
Total cost per joint, hand caulking	$7.90

There was, therefore, a saving of $2.60 per joint, or about 33 per cent. The daily cost reports, to date on this particular line, have checked this figure very closely, the saving of air over hand work averaging about 30 per cent.

On the line in question there were, roughly, 750 joints. Taking the average cost per hand caulked joint as $7.11, the total cost of hand caulking would have been $5,332.50. The total saving, using air tools, would, therefore, be very cloce to $1,600, so that the outfit will practically pay for itself in the first season's work.

These figures are quite conservative. While the weather conditions were ideal quite a little time was lost in shifting the compressor around, as pipe was being laid at two different points on the line, and it was never possible to have a straight run to caulk of more than 300 feet. There were also days when there was no pipe ready for caulking. When this condition arose, the foreman and compressor engineer overhauled and cleaned the compressor and the air hammers, and the caulkers were put to work as laborers.

The ability to caulk several joints quickly proved of great value on this line, in allowing some rather bad street intersections to be finished up and back-filled with the least possible delay. While the money value of such a saving would be rather hard to compute, it must be quite an item when we consider the maintenance of intersecting pipes and sewers, sheeting, shoring, temporary bridges, night and-day watchmen, and the ever present possibility of accidents to vehicles and pedestrians while the street is open.

We were quite pleased to find we were able to get from 10 to 15 per cent. more lead wool into these joints by means of the pneumatic tools than we had previously been able to get by hand. This proved conclusively that pneumatic caulking gives a more compact, consequently a more nearly gas tight joint than the old method.

The second compressor to arrive was the National Brake and Electric outfit. This was placed on a 36-inch line and, after spending some time breaking in the caulkers, a gang was organized along the ideas described above. The same difficulties were experienced at first. A few tools were broken, and the compressor stopped unexpectedly a few times, but finally things were licked into shape and we began to get results. The compressor on this line was larger than that on the 48-inch, and it gave excellent service drilling rock, at the same time running enough hammers to keep all the caulkers busy. At the present writing there has been more rock drilling on this line than caulking, so there is still room for improvement in the cost figures. This will, undoubtedly, come with practice and systematization of the work. Taking an average daily report from this line, the cost per joint figures as follows:

[1]Total labor and compressor cost	$17.75
No. joints yarned and caulked	9.60
Cost per joint	1.85
Plus depreciation on outfit, per joint	0.30
Total cost per joint	$2.15

Also 41 feet of 1-inch hole, drilled at a cost of 21 cents per foot.

The cost of hand caulking per joint would have been as follows: To do nine 36-inch joints a day would take a gang of 10 hand caulkers at an average rate of $2.75 per day. A pair of good hand caulkers can do two joints in a 10-hour day, but the average will be a little less than that. No time for a foreman caulker is charged, as the pipe foreman on this line looks after the caulking and, for a given number of joints, his time would be the same for both compressed air and hand work:

10 caulkers at $2.75	$27.50
Labor rolling lead	1.00
Total cost, 9 joints	$28.50
Cost per joint	$3.17

This gives a saving per joint in favor of compressed air caulking of $1.02, or about 32 per cent.—very close to the average percentage of saving on the 48-inch work. It will undoubtedly be possible to cut the cost per joint on the air work still further when it is not necessary to drill rock and caulk at the same time. The drills use a large amount of air and make it impossible to run more than 6 caulking hammers. The compressor can easily run double that number, and the fixed charge per joint (which is a fair sized item) could, therefore, be cut in half. The caulkers will also in time become more expert, thus increasing the number of joints per day. The working conditions on this line were not as severe as on the 48-inch previously described, but when we stop to consider that more than half the caulkers were absolutely green (not even having a hand caulker's experience), the results are very encouraging. Caulkers are not always numerous in New York City, and if it is possible to break in absolutely green men as quickly and satisfactorily as this, our troubles are ended in this direction.

The compressor outfit furnished by the National Brake and Electric Company proved quite satisfactory. A $2 per day laborer, who had never seen a gasoline engine before, was able to run it without any trouble, and the repairs cost next to nothing. The only possible objection to this outfit was the inability to move it readily on account of its weight. We expect to purchase a smaller outfit of this type of ½ the air capacity and about ⅓ of the weight to be used for caulking. The larger compressor will then be used exclusively for rock drilling where it is not necessary to make as many shifts.

It might be well to add that a compressor need not be looked upon as a dead loss during the winter months, or when no outside work is in progress. There are many ways in which compressor air tools can be used to advantage on repair jobs around the works, and the testing of long stretches of main becomes an easy matter with a ready supply of air at any required pressure always at hand.

We were so well pleased with the results on the 48-inch and 36-inch lines that a third compressor outfit, of the Ingersoll-Rand-Abenaque type was ordered for use on the 30-inch work. This compressor, unfortunately, arrived a little behind schedule and we were only able to use it for 2 weeks when the work was temporarily suspended on account of a delayed shipment of pipe. The results obtained in these 2 weeks were quite promising though, and with very little practice a pair of caulkers would be able to do 5 joints per day, as against 2 by hand. This would give a saving of about 30 per cent. and possibly better, as the working conditions here are ideal. The caulking gang was organized on the same basis as that described for the 48-inch line, and past experience enabled us to eliminate most of the troublesome features.

The average air pressure carried on the receiver gauge was about

1. On this work we were able to obtain caulkers at an average of $2.50 per day, as against $3 on the 48-inch line

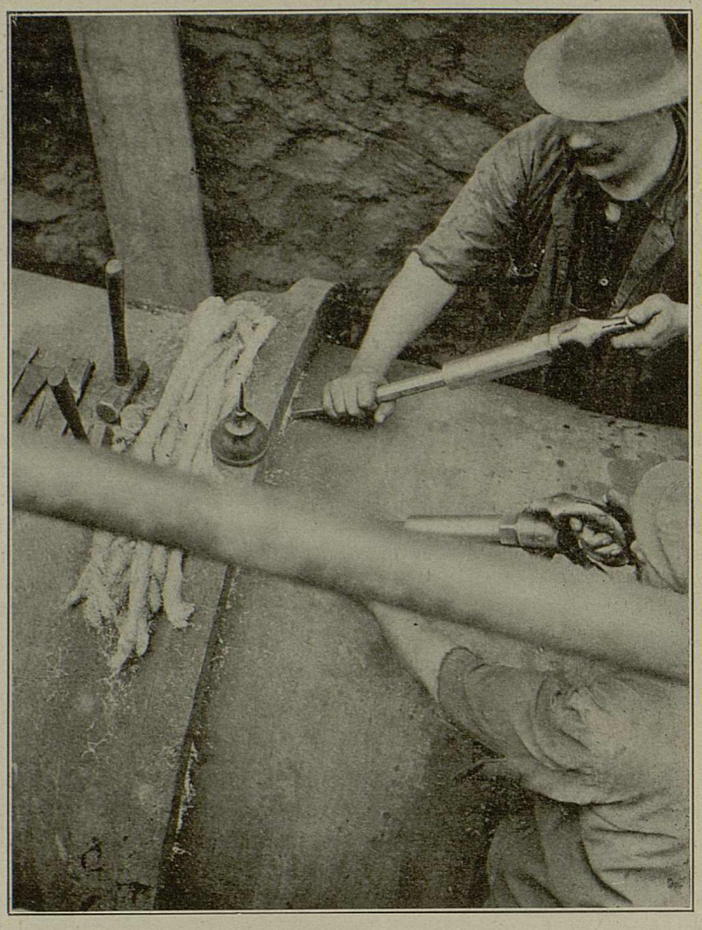

Fig. 8.

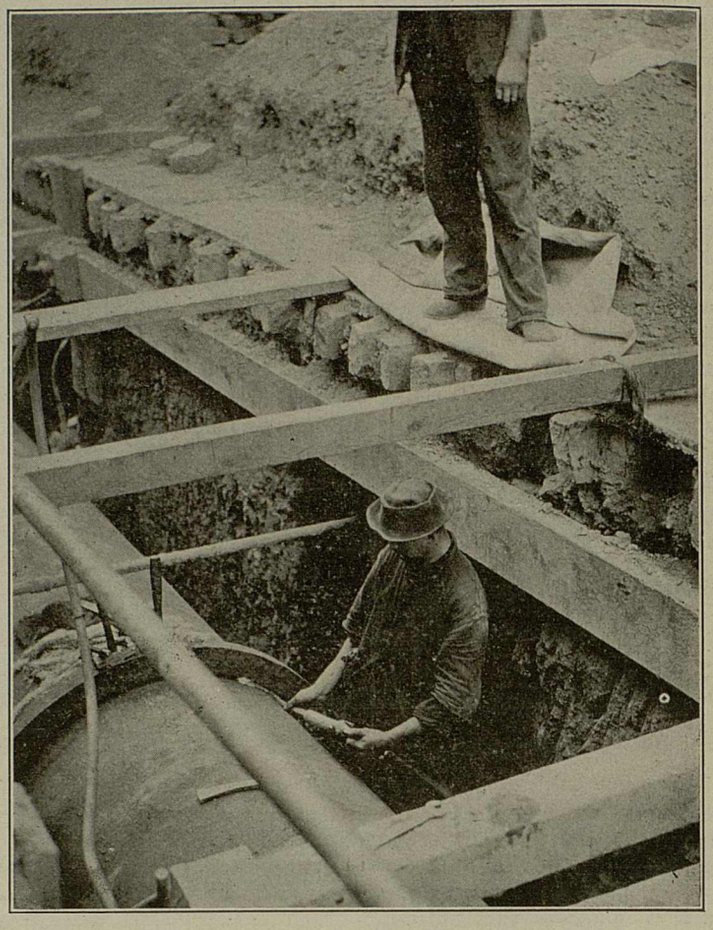

Fig. 9.

FIG. 10.—DAILY REPORT.—COMPRESSED AIR CAULKING.

48th–134th St. Line. Type of compressor, Ingersoll-Rand-Abenaque. Type of hammers, Ingersoll-Rand. Weather, fair morning; showers afternoon. Date, Aug. 9, 1910.

Name.	Grade.	Rate.	Total Hours Worked.	Number of Joints Caulked.	Joint Number.	Time of Yarning.	Time of Caulking.	Total Time for Joint.	Weight of Yarn, Pounds.	Weight of Lead, Pounds.	Time on Work other than Compressed Air Caulking. State Nature of Work.	Compressor.				Hammers.			Remarks.
												Total Hours Running.	Gals. Gasoline Used	Quarts Lub. Oil Used.	Repairs.	Total Number on Hand.	No. in Use.	Repairs.	
E. Guiry	Caulker	$3.00	10	2	1	50′	2:45	3:35	13⅓	157	All	7:10	8	1	None	8	7	None	Delayed 1 hour 50 minutes waiting for joint holes to be dug. Also delayed ½ hour by pay master's wagon.
D. Mahoney	Caulker	3.00	10		2	50′	2:55	3:45	14¼	160	hands								
T. Dillon	Caulker	3.00	10	2	1	50′	2:55	3:45	14½	158	made								
D. Cregan	Caulker	3 00	10		2	45′	2:50	3:35	14	158	300′								
C. Gruber	Caulker	3.00	10	2	1	45′	2:45	3:30	13	143	shift								
H. Daniels	Caulker	3 00	10		2	45′	2:45	3:30	13¾	155	with								
B. Costello	Caulker	3 00	10	2	1	45′	2:50	3:35	14¼	166	com-								
F. Hogan	Caulker	3 00	10		2	50′	2:50	3:40	14	168	pressor								
T. Skelley	Foreman Caulker	3.00	10																
S. Salt	Comp. Engineer	3.00	10																
M. Cunningham	Tool man.	1.90	10																
Labor rolling lead wool		2.56																	
Total		$34.46		8															

Total labor and compressor cost (compressed air caulking only), $35.36. Total number of joints (compressed air caulking only), 8. Average cost per joint, $4.42 + depreciation, .30 = $4.72. Hand, $7.11. Saving, $2.39, or 33 per cent.—G. A. SHERRON, Field Engineer.

70 pounds. This gave from 50 to 65 pounds pressure at the tool and was found quite sufficient. The compressors were all fitted with unloaders, which, when set for any given pressure, regulated the air supply automatically. From the results obtained on these 3 lines, it would certainly seem that pneumatic caulking of lead wool joints gives better and quicker work with a considerable saving in cost. The caulkers themselves are better satisfied, as their work is much easier and it takes considerably less time to break in a man as a pneumatic caulker than it does to get him in shape to swing a 3½-pound hammer for 10 hours. As I have stated before, the supply of caulkers in New York city is not always equal to the demand.

Discussion.

The President—Gentlemen, there are three written discussions on Mr. Simpson's paper. As some of the authors of these are not present, Mr. Earnshaw will read the discussions.

Mr. Earnshaw—This is a discussion by Mr. J. D. Von Maur, of St. Louis: I have read Mr. Simpson's paper with a great deal of interest. A number of years ago we experimented in St. Louis with pneumatic caulking in laying our 24-inch high pressure lines, using cast lead for making the joints. We did not find the result satisfactory, either from a cost standpoint or the character of the work obtained. The reasons were substantially as stated in Mr. Simpson's paper. The best results with hand caulking, using cast lead, are obtained by using light sledge-hammers for caulking instead of the ordinary caulker's hammer. The work is not only better, but the joint is completed in considerably less time. With the use of lead wool, however, the proposition is entirely changed. Here we have a

material which, from its nature, involves a great deal of labor to caulk the joint satisfactorily. The hand labor cost is increased very greatly, and Mr. Simpson has demonstrated that, where there is sufficient work to warrant the purchase of a plant, this labor can be done at a reasonable expense, and undoubtedly gives a very much tighter joint than could possibly be obtained by either cast lead or cement. I would like to ask Mr. Simpson under what gas pressure these cast iron mains are tested and operated, and whether any of the joints leaked on the test made after the joints were caulked; also, have any of the joints leaked in actual operation? It is, of course, understood that these joints are very much tighter and remain so, than where the joints are made with cast lead; otherwise there would have been no object in going to the greater cost of using the lead wool. In St. Louis all our mains are laid, using Portland cement for joint caulking purposes. For joints 12 inches and under there is absolutely no question as to the value of cement for this purpose with 5 pounds operating pressure. The idea that mains laid with all cement joints have a tendency to break has not been borne out in our practice, as we have not had a single main broken from this cause out of a total of several hundred miles. We also laid a 30-inch cast iron main, with cement joints, which is operated under low pressure, and although this main has been in use for several years we have never had any leaking joints on it, but with the 24-inch mains, which are operated under 5 pounds pressure, we have had considerable difficulty, yet I am satisfied that these mains can be laid, using cement for the joints, which will remain absolutely tight. My reason for so believing is the fact that we have many long stretches where no leaks have occurred. If it is possible to lay one stretch of main which will remain tight it would seem that mains, laid in precisely the same manner, and under the same conditions, should also remain tight. Unfortunately we stopped using Dyckerhoff cement and substituted a local Portland cement, which is one of the best in the market for ordinary purposes, but gave us considerable trouble when used for joints. The great trouble with using cement is the fact that it may test very well when laid, but may leak after 6 months or a year. Most of our joints were absolutely tight at 30 pounds pressure 24 hours after they were laid, yet these same joints leaked after being in the ground 6 months. This illustrates the danger of experimenting on a large scale with cement, especially in a large city, where the cost of repairing joints is very great. The difference in cost of using cement and lead wool, however, is so great that it would seem that the large gas companies should carry on the work of experimentation until it is definitely decided at what size main the use of cement is no longer economical. But where it is decided to use lead wool on a large scale the caulking should certainly be done with pneumatic tools, otherwise the labor is well-nigh prohibitive. All gas men having to lay large size mains will certainly appreciate Mr. Simpson's paper on this practical question, and the full details will be a guide for anyone planning future work.

Mr. Earnshaw then read the following written discussion by Mr. A. H. Hall:

Mr. Simpson has prepared a paper which will prove of value to every member of the Institute who is connected with the street main department of a company. The only form of discussion which suggests itself to me is one which lays emphasis on the difficulties encountered, so that they may be avoided in future operations. In his first paragraph Mr. Simpson gives two main reasons for the failure of the earlier experiments of the Consolidated Gas Company. Neither of these to my mind gives the real reason. The first of these, the well-known fact that cast lead cannot be compressed by caulking for more than $\frac{1}{8}$ inch to $\frac{3}{4}$ inch back from the face of the joint, applies with equal force to hand work. The second reason is also fallacious, as the time could have been reduced had the proper tools been used, in practically the same proportion with cast lead joints, as with those in which lead wool is the medium. In the Central Union Gas Company we first started to caulk with pneumatic hammers, in 1904. The Company had purchased a portable gas engine, air compressor outfit for use in rock drilling, the argument being that a gas engine was a better advertisement for a gas company than a steam boiler. This plant was first used on a 24-inch line in which cast lead was used for the joint making material. After the outfit had proved a success at rock drilling, we experimented with it for caulking. We asked the hammer manufacturer to give us pneumatic tools which would strike a blow equal to that struck by a man using a 3½ pound hammer, and made our caulking tools of the same width and depth of face as we had been using in hand work. This trial was an absolute failure; first, because the hammer was too heavy to be handled in the trench; second, because the very rapid movement of the piston made it impossible to deliver less than 7 or 8 blows of 3½ pounds force at each setting of the tool against the face of the joint; third, the caulker didn't want it to work. In our next trial we used a hammer of about half the size and increased the width of the face of the tool to about 2½ inches. The labor question we solved by giving the hammer to a bright Italian laborer, with the promise of an increase from $1.50 to $1.75 per day "if he made it work." After a little practice this man turned out very satisfactory work, and did twice as many joints per day as the hand caulkers. Mr. Simpson has been rather unfair to the pneumatic system in his method of charging depreciation. If 30 cents per joint is the correct figure when the outfit is being operated at the rate of 19 joints in 3 days, or 6⅓ joints per day, it is manifestly too high, when 8 joints, or 9⅔ joints, are finished per day. This is particularly true of the latter case where the machine is credited with rock work to the value of (41 feet + 0.21c.) $8.61 on the same day. The estimated figures for hand labor also seem too low if worked out on the same assumptions as were used in the case of the 48-inch work. In the latter case it was assumed that 2 caulkers could finish one 48-inch joint per day of 10 hours. Working at the same rate they should finish one 36-inch joint in ¾ of a day (7½ hours) or each 36-inch joint would require 15 hours' labor. On this basis the estimated cost would work out as follows—the caulkers being charged at 30 cents for comparative purposes:

9 joints at 15 hours per joint; 135 at 30 cents	$40.50
Labor rolling lead	1.00
	$41.50
Cost per joint	4.61

which would show a saving of $2.46 per joint or about 53 per cent. There seems to me one point to which Mr. Simpson might have drawn greater attention, and in the light of the modern humane practice of bettering laboring conditions wherever possible, it is of undoubted importance. In caulking any kind of a lead joint in a trench by hand, the men wielding the hammers work under extremely hard conditions. The positions in which they must place themselves in order to properly address their work are almost always cramped and uncomfortable. I have frequently seen caulkers lying on the pipe to caulk the underside of a joint when the iron was so hot, from exposure to the sun, as to be almost too warm for me to bear my hand on. In caulking sizes larger that 12-inch it is necessary for 2 men to work at the underside of the joint. They lie on their backs in the bell hole, and one man holds the caulking tool against the lead while his mate strikes it with his hammer. It is very difficult for a man who is not ambidextrous to caulk both sides of a large joint. All these conditions make the work of a hand caulker very trying, and although the pneumatic hammer does not take him out of the trench, it does help him to do his work with a smaller expenditure of muscular effort.

The President—Is Mr. Walton Forstall present?

Mr. Walton Forstall—I was not sure that I would be here, so I put my remarks in writing. Some of the points have been made by some of the other members in their discussion. I am glad to be asked to discuss this paper of Mr. Simpson's, first, because joint making is one of the most important distribution problems; and, second, because I had the pleasure this summer, under Mr. Simpson's guidance, of seeing pneumatic caulking of 48-inch joints, Anyone who has had to do with large mains under expensive paving, realizes that a method of joint making, which produces not only tight joints, but joints that *stay* tight, may greatly exceed in first cost a cheaper method, and yet in the long run prove more economical than the cheaper method, if the latter results in many leaky joints year by-year. This undoubtedly is particularly true where the main in question is a 48-inch and the city New York. Therefore, I consider that, without the actual saving Mr. Simpson has shown for pneumatic caulking over hand caulking, it would still have strong claims for consideration under his conditions. I say this because I believe that pneumatic caulking renders much more certain the uniform and proper compression of the lead wool. Right here, however, I wish to say that my experience with lead wool has been very limited. Such as it is, it has left me with the impression that, when using lead wool, more attention must be paid to the caulker and his work than is true of cast lead joints. This for the reason that the only justification, for the extra first cost of a lead wool joint over one of cast lead, lies in the fact apparently pretty well demonstrated that it is possible for this extra first cost to secure a joint that stays tight. This permanent tightness

results only if the lead wool is properly caulked, in which case a joint of about the same density as the ½ inch or ⅝ inch of the compressed layer of cast lead is secured for the *whole* depth of the lead wool joint. This subject does not appeal to the small gas works, but the large cities should keep in touch with this matter, as further experience may show that pneumatic caulking pays in sizes as small as 20-inch. The Technical Committee should obtain next year a further contribution from Mr. Simpson, giving another year's experience. If a record is available, showing the percentage of leaking joints found each year, to the total joints in service, divided as between cast lead, lead wool (hand caulking) and lead (pneumatic caulking), these facts, after 10 years or so, would be very valuable to all companies laying large pipe. In the meantime, Mr. Simpson is deserving of our thanks for having blazed a new trail and brought it to our notice. I have already stated that Philadelphia has done little with lead wool. It has, however, had a larger experience with cement joints than any other city, and what follows is given as being of value to Institute members. The practice of using cement instead of lead for small pipe was begun in 1900, and, in 1902, extended to all sizes. From the beginning, a careful record was kept of all leaks found in cement joints, because it was thought important to know *exactly* what success, or failure, was met with. The results to the end of 1909 are as follows:

Size of Pipe, Inches.	Feet Laid.	Leaky Joints.
4	105,124	7
6	1,333,953	25
8	49,891	3
12	59,967	19
16	33,687	54
20	51,833	99
30	20,521	332

The record is entirely satisfactory, except for the 30-inch. Half of this pipe was laid by "A" district organization and half by "B." On the "A" half, 310 leaks have been found; on the "B" half only 22. This being the case, it seems as if the "A" caulkers did not possess the knack of those employed in "B" district. At any rate, as long as 10,000 feet have only shown 22 leaks in 4 to 8 years, we do not believe it is impsssible to make a 30-inch cement joint that will stay tight. We have not been able to arrive at any definite opinion why there have been so many failures in "A" district. Ground vibration, due to railroad trains, and settlement due to shifting gravel, are two causes that may have had some effect; but personally I believe that the fault lay in the "man behind the hammer," and that "B" district obtained a stronger adhesion between cement and iron than did "A" district. In almost every case the crack was a very fine one. It showed no partiality for any particular portion of the circumference, and the cement separated from the spigot as often as from the bell. In order to eliminate settling from the causes of joint leaks, two years ago it was decided to use concrete piers, two under each length, when laying 1,200 feet of 36-inch pipes. So satisfactory was the experiment that this spring the same support was given to 3,000 feet of 30-inch. Data from these lines will be interesting after some years have gone by. Of course, the most satisfactory feature of cement joints lies in their cheapness. In round figures, Philadelphia must have saved $100,000 by the substitution of cement for cast lead.

The President—Are there to be any other remarks on this lead wool caulking? If not we will call upon Mr. Simpson to close the paper.

Mr. Simpson—There is nothing further I care to say in this connection except with reference to the shape of the caulking tools, Fig. 1. We tried all sizes and shapes of every size and finally adopted this style. This tool is about a square inch of metal. We found it made a good sized test. We get plenty of pressure from the hammer and just do the caulking so much quicker. If we had a little tool like a hand tool we just punch a hole in the lead. This table of the different sizes of tools is what we are using at present, but you practically have to evolve your own tools for the different sizes of pipes, depending on the pipe you use and the amount of lead space you have. In regard to the tests on this line, question of leakage, I would say that the line is not yet completed, so we have not made any tests of any kind. It is not our practice to make pressure tests. But I would say in that territory a 30-inch line was laid about 2 or 3 miles long. It has been in service 3 years. The lead wool is hand caulked and there has not been a single leak on it. Now, if we get a better joint with air than we do by hand, we ought to have better than no leaks in the 48-inch line.

Mr. Earnshaw—Mr. Simpson did not answer the question which was of interest to me, as to the operating pressure of this main and the pressure under which it would be tested. If he would give us definite information on that point I think we should be glad to hear it.

Mr. Simpson, Jr.—I think I stated that it has not been our practice to make pressure tests on mains, if that answers the question, and the operating pressure would not be more than ½ a pound. It is a low pressure line.

Mr. Earnshaw—What is the operating pressure on this 30-inch main?

Mr. Simpson, Jr.—About 2½ inches. They are all low pressure lines.

The President—If there is no objection we will pass a vote of thanks to Mr. Simpson for his paper. [Adopted.]

Mr. Simpson, Sr.—I have proved conclusively a great many years ago that I can take a cast iron main of any size, whether 4, 6, 30, 36 or 48 inches in diameter, have a caulker pass his chisel around that joint, and I could test it up to 5 pounds and show tight, but it would only show tight about a week. That to my mind shows the fallacy of any test of a large main being any good when it is made immediately after the main is laid. The trouble comes, not from the caulking of the joint (the joint is nearly always tight at starting), but with a large size pipe the least settling upsets the caulk and the joint commences to leak.

(To be Continued.)