

FINDS ELEMENTARY RULES OF ENGINEERING SLIGHTED

(Continued From First Page.)

leaking of melted snow onto the heads of the audience would have resulted.

In figure 1 the double lines indicate the six roof trusses, while the single lines indicate the steel I-beams or girders connecting with the trusses. Four of the trusses connected at one end of each to the main truss, No. 11. One truss, No. 16, extended from the east wall to column No. 5. The main truss, No. 11, was at right angles to the other trusses, and its north end rested upon the curved wall on the Columbia road side of the building. Its south end was supported on the upper end of a column (No. 2), at the level of the ceiling. This column, unlike column No. 3, did not extend to the roof, but stopped at the level of the suspended ceiling, which was about six or seven feet below the roof.

Supported by Vertical Strut.

The three roof girders meeting at the point over column No. 2 were supported by a vertical strut, consisting of two small steel angles, which strut stood upon the bottom chord of truss No. 11, directly over the top of column No. 2. It should be observed that there is no steel member extending west from the end of this strut. This strut was supported "cobbler" fashion, not being rigidly connected at its base and not connected directly to the column below, contrary to accepted practice. See figure 8.

Truss No. 12 is the one which appears in the various photographs of the interior taken since the collapse. It is altogether, but has a bad break in its upper or compression flange. This break is evidently due to tension developed by a tremendous side pull which probably came with the general collapse, rather than being the cause of the collapse.

Figure 2 is a sketch to larger scale, of the top of column No. 3 and shows the relative positions of the four roof members connecting at this column. Perhaps it is well here to call attention to the fact that all of these connections were made with loose fitting bolts instead of rivets. It may be permissible to make steel connections with bolts in a framework of short spans, but given rivets in the connections for work of this character. Where bolts are used the number should always be greater than would suffice for rivets, which is not the case here.

Figure 3 is an elevation or side view of a part of the connection shown in plan in figure 2. This shows that beam B-41, a 12-inch I-beam, was connected in a most flimsy fashion to its support, which was a short section channel twelve inches high and half inch thick standing on angle brackets, connected to the column.

The upper flange of this channel was not fastened to the column in any way, so that a very slight movement of beam B-41 would certainly cause the web of the channel to fold over, bending near its bottom flange, and this is just what did happen to this channel support, as shown by dotted lines on figure 3.

Figure 4 is a sketch of the connecting beams and the angle struts above column No. 2. The west end of beam B-41 was connected by a bent plate bolted to the 10-inch channel.

Figure 5 shows a side view of this connection to the west end of B-41 to the 10-inch channel. This connection was made by bolts through the bent plate and the web of the channel, and this connection is still intact in the wreckage.

Only Three Bolts Carry Load.

Figure 6 shows the connection of the same 10-inch channel to the vertical 3-inch by 4-inch angle by means of three bolts. Notwithstanding the fact that the load from B-41 was delivered to this channel by six bolts and that the channel was also called upon to carry in addition a considerable area of the roof, only three bolts were provided to transmit all of this load to the supporting column. During the collapse this channel was torn away from the angle support and one bolt head was bent clear through the thin steel web of the channel.

Referring back to figure 1 it will be noted that in connection with the point of support over column No. 2, and cause a movement of B-41, there was no member extending westwardly to resist such force, but the slightest movement of B-41 would tend to upset the light angle struts which rested so insecurely on top of the truss below.

Figure 7, drawn to scale, shows the relative positions and the unbraced condition above the balcony of column No. 2, and also of the angle strut above it. Whether or not there was a member in the plane of the ceiling between columns No. 2 and 3, but this critical detail was discovered, doubtless because column No. 2 would not stand alone and had to be held up by the truss below. The ten-inch I-beam strut was provided at the ceiling level as shown. This was not rigidly connected by two bolts to the flange of the truss through a flat plate.

Splice Plates Ineffective.

Columns Nos. 2 and 3 were each spliced above the balcony level to similar columns which extended from the foundations up and through the main floor. These columns were more slender for their lengths than good practice warrants. The connections between the upper and lower columns were entirely inadequate to develop the bending strength of these columns and when subjected to forces tending to move their top laterally they simply broke away from the ineffective splice plates just above the balcony.

Figure 8 shows the manner in which the main truss was connected to the top of column No. 2. Sketch (a) of figure 8 shows the top of column 2 as looked down upon, when it was in position. The four lug angles on this column were presumably set level and flush with the top of the column section, which was cut square to the column axis. However, it is practically impossible to rivet four lug angles onto a column in perfect alignment and one or more will be found a little too high or a little too low, or slightly out of level. Therefore, good practice requires that a cap plate be riveted to the top of such a column in order to distribute the load uniformly over the section of the column. No such cap plate was used. Not less than seventy-five tons of load had to be delivered to this column at its top, and examination shows that a groove had been worn into the bottom of the steel truss where it rested on the edge of the "H" column. This indicates that the deflections and temperature changes in the truss had actually caused measurable movement at this point. Sketch (b) of figure 8 is the elevation or side view of this connection of the truss to the column, and sketch (c) shows the lug angle at the base of the angle strut, with but two bolts to fasten it to the column.

In a structure so poorly designed and detailed as this, and about which at this time only a limited knowledge was available, it is hard for the writer, there seems more evident reasons why failure should occur than why it should not.

Four years. The writer has not had an opportunity to check the original stress sheets, but the engineering calculations and reports of the investigation and report.

DRAWINGS BY THEODORE L. CONDRON EXPLAINING KNICKERBOCKER COLLAPSE.

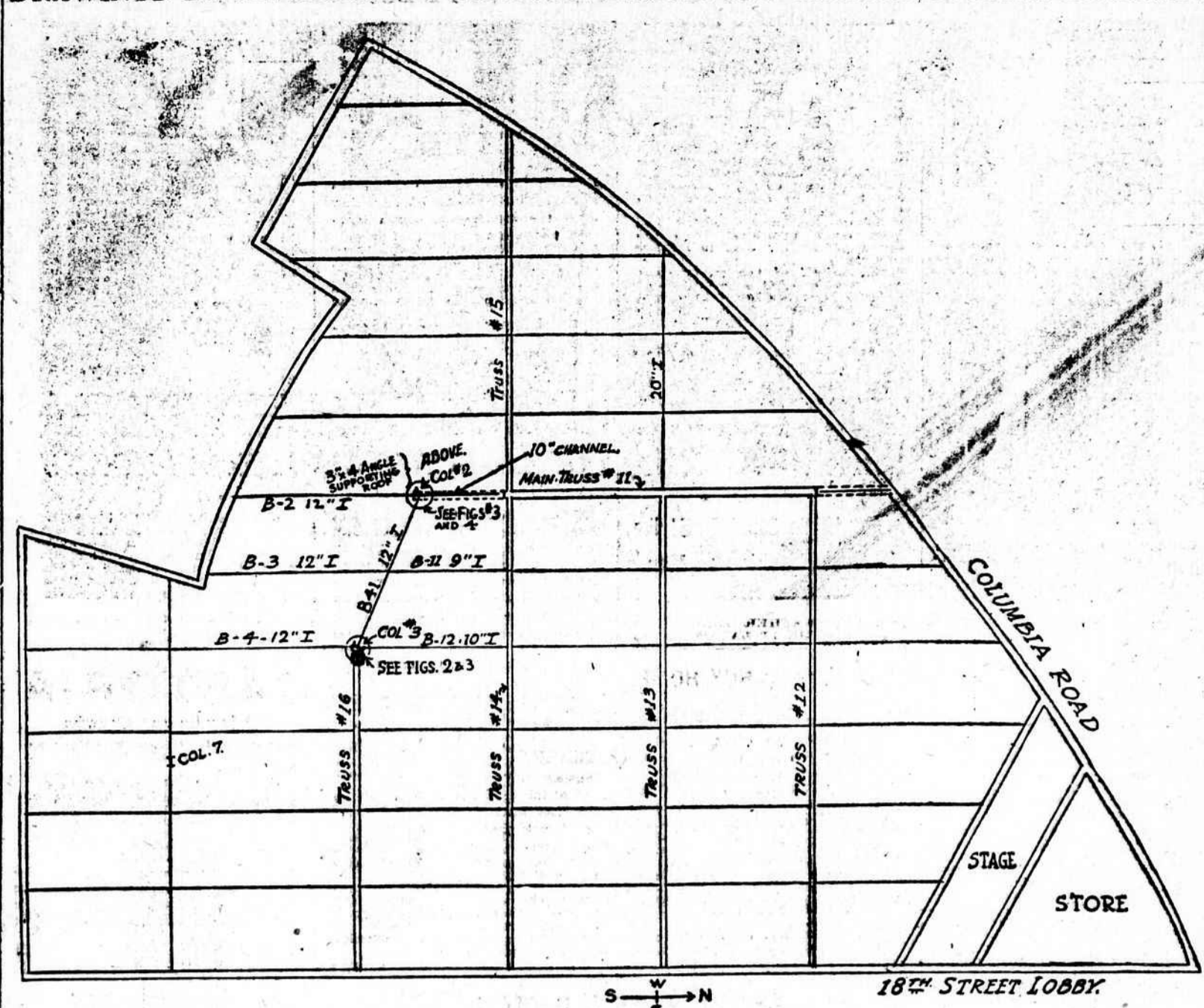


Fig. 1 ROOF PLAN - KNICKERBOCKER THEATER.

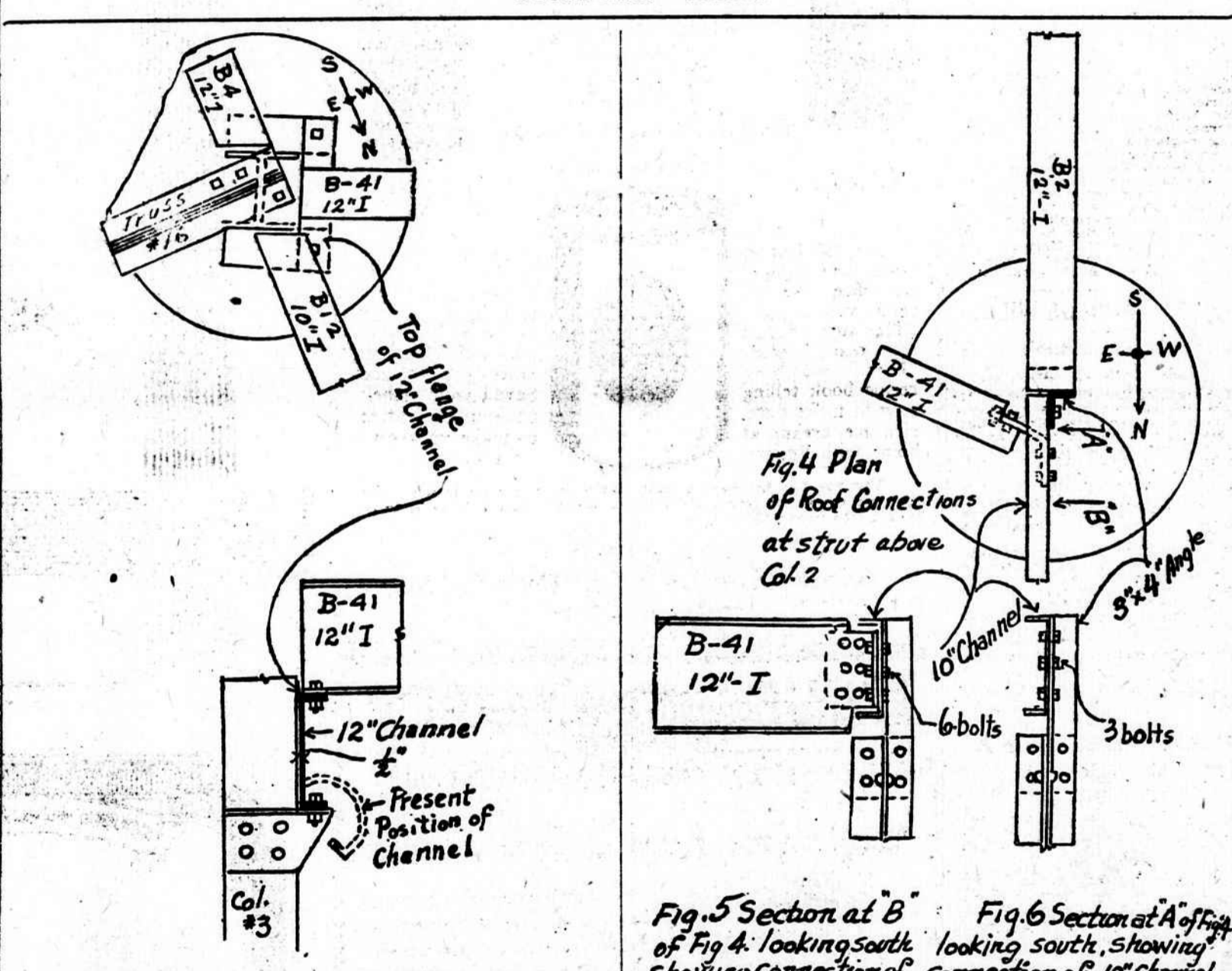
Single Lines- Beam or Channel
Double Lines- Trusses

Fig. 4 Plan of Roof Connections at strut above Col. 2.

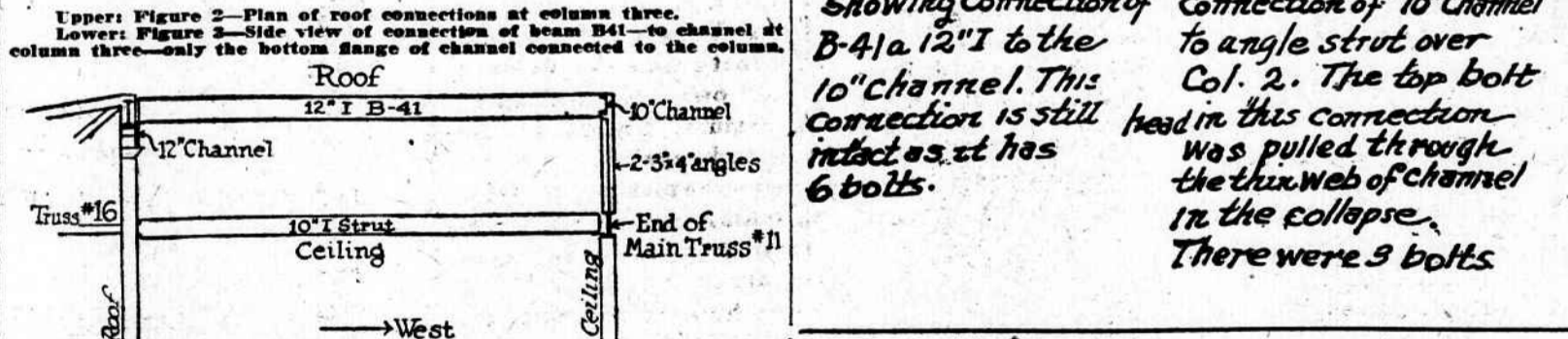


Fig. 5 Section at B' of Fig. 4, looking south, showing connection of B-41 a 12\"/>

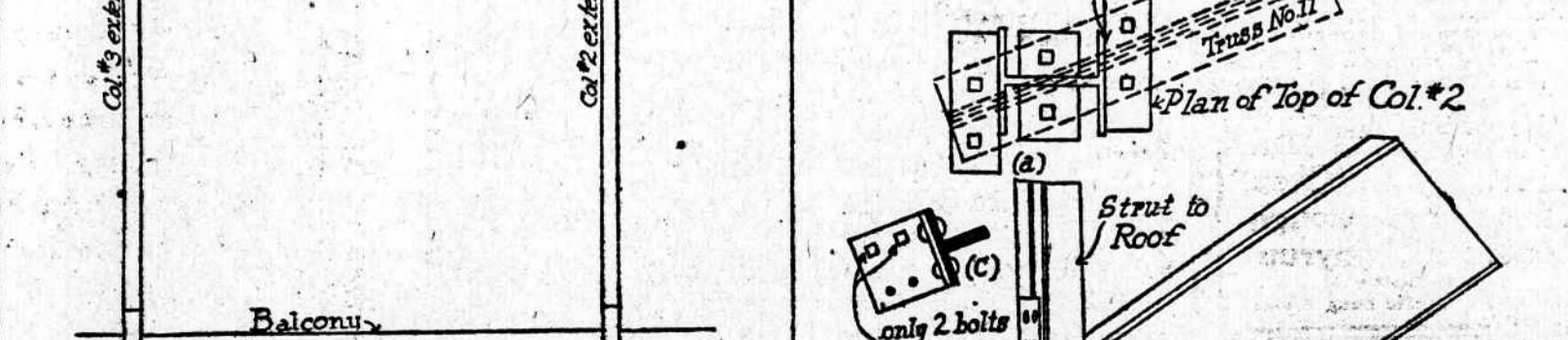


Fig. 6 Section at A' of Fig. 4, looking south, showing connection of 10\"/>



Fig. 7 Showing that Col. 2 and the Strut supporting roof beams were not braced on the East side.



Fig. 8 Plan and side view of Connection of Col. 2 and Truss #11.

SNOW FOUGHT WHILE FALLING UNDER PHILADELPHIA'S SYSTEM

Fleet of Speedy Motor Plows, 4,390 Men, 1,110 Teams and City's Sewers Keep Streets Cleared.

BY COL. JAMES B. MCCORD.

U. S. Bureau of Public Roads, Formerly Engineer of Highways, Philadelphia, Pa.

The writer has read with a great deal of interest the efforts of The Evening Star to collect data from various cities concerning their methods and organization for snow removal. It is thought that it might be of interest to your readers to learn something of the system in operation in the nearby city of Philadelphia.

An engineer of highways of Philadelphia for five years between 1912 and 1917 the writer was in charge of the removal of snow from the city streets during that time, and therefore had more or less to do with the inauguration of a new idea in handling snow. Philadelphia was the first city to regard snow removal as an engineering problem amenable to solution by the application of ordinary engineering rules. Prior to 1912 snow removal in Philadelphia and in other American cities, had been considered an emergency duty to be performed after the snowfall had ceased rather than a routine function which became operative as soon as the snowfall had started and should continue throughout its progress.

On Christmas eve, 1912, Philadelphia was visited by a very severe snowstorm, quite like the recent one in Washington. After the storm began the writer was placed in charge of the removal of the snow from the streets. Neither he nor any of his engineer colleagues had received any instruction from the city government as to what to do. The writer, however, had had many years of experience in such work. Therefore, following the custom of the years, the storm was allowed to complete its damage before any work of removal was begun. The next morning the snow had reached a depth of nearly two feet and, with the exception of a very few city streets, the removal of the snow was left to the officials who were able to induce to work for emergency prices the snowmen who remained in the streets until it melted and Philadelphia founded around over a week of snow. The writer, however, had had many years of experience in such work. Therefore, following the custom of the years, the storm was allowed to complete its damage before any work of removal was begun. The next morning the snow had reached a depth of nearly two feet and, with the exception of a very few city streets, the removal of the snow was left to the officials who were able to induce to work for emergency prices the snowmen who remained in the streets until it melted and Philadelphia founded around over a week of snow.

Begin When Snow Starts.

This one experience with time-honored methods of snow removal was quite enough for the writer. In charge of the work, and they immediately began to put into effect an entirely new practice, namely, that of fighting the storm and beginning the fight shortly after the snow had commenced to fall. The writer suggested that the fundamental problem was to maintain normal traffic conditions as nearly as possible during and after the storm. This was accomplished by fighting the storm. The actual disposal of the snow is, of course, important, but it is of secondary importance.

Almost all snowstorms in Philadelphia begin in the afternoon or at night, and as it was found almost impossible to induce many men to shovel snow during the day, it was decided that the main night work must be done with some kind of plowing machine. To keep the snow from being piled up in the streets clear as the snow fell, horse-drawn road scrapers were tried out and found to be inadequate. They were too light and moved too slowly. What was needed was speed combined with efficiency. Several contractors operating large five and ten ton motor trucks were persuaded to equip thirty of them with adjustable plow blades fastened to the front of the trucks and arrangements were made whereby these trucks with their crews were available day and night. They were paid by the truck-hour. The tremendous value of these powerful plowing trucks during a snow storm is quite apparent when it is realized that they can plow to a depth of six or eight feet, at a speed of from twenty to twenty-five miles an hour. The street railway company at the city's request equipped its cars with front and side plows to supplement their sweepers.

Divided into Districts.

The central business portion of the city was divided into nineteen snow districts, comprising about thirty miles of street. Detailed plans of these districts were prepared showing the sewer manholes which might be used for dumping the snow. Where it was found that even the regular flow of water in the sewers was insufficient to carry the snow, the manholes were fitted with water connections to increase flow. Bids were received by the city from teaming contractors for the removal of snow within the nineteen snow districts. Not more than two districts were awarded to any one contractor. The basis of payment was per cubic yard of snow disposed of in manholes or other dumping places indicated on the plans. The contractors were subject to call, and were required under penalty to have a certain number of men and teams at work within their respective snow districts within one hour after the snow began to fall. The total force required for the nineteen districts was 2,900 men and 800 teams and trucking street cleaning force was also organized for snow work. This force included 1,200 men and 200 teams and was required to clean the crossings in the central part of the city and to clear the streets in the outlying sections. The municipal repair and sewer gangs consisting of 1,110 men and 110 teams, were an extra force available for snow work in severe storms, thereby making a grand total of the snow force of 4,390 men and 1,110 teams and trucks, thirty heavy automobile plow trucks and eighty trolley plows.

140 in Supervision Work.

To control this force the work was done under the supervision of the writer, who had an engineering and inspection staff of about 140 men, who were available day and night, working, however, in two shifts of twelve hours each. Each man had a definite assignment. The organization was as follows: Two division engineers—one in charge of the nineteen snow districts and of fifteen automobile plows and one in charge of nine of the districts and of the motor plows. To each of these division engineers was assigned a chief inspector, who assisted him in general supervision. To each of the thirteen snow districts was assigned an inspector-in-charge, assisted by six

subordinate inspectors. Each inspector in charge of a district was provided, of course, with a set of plans and specifications and was required to keep in close touch with his contractor by telephone, to be familiar with the location of the plow trucks and the addresses of the crews. The police precincts also cooperated in making and mobilizing contractors and city laborers for snow work.

The city telephone bureau in City Hall was on duty day and night and was required to notify the writer by telephone at the first sign of snow during the night. It was then his duty to determine whether it would be necessary to order out the snow plows. If so, he notified his two principal assistants by telephone. They in turn called their inspectors in-charge of districts. These inspectors notified the plow contractors and within one hour after decision to begin plowing thirty powerful fast-moving plow trucks were working in the snow districts. When it was decided that the storm would warrant calling out the snow-removal force of men, trucks and teams word went forth to that effect by telephone to the contractors and city workers quickly to the laborers, through the police offices. Usually by 6 o'clock on the first morning of the storm upward of 4,000 men and 1,000 trucks and teams were at work. The plows, working in the main thoroughfares, cleared the main thoroughfares of the city and traffic conditions were almost normal. And after the plows had finished the central streets they went to outlying sections, even, in fact, on main country roads, where they opened up main or butters.

Formed Within Three Weeks.

The snow organization described above was completed and put into effect in Philadelphia within three weeks of the snowstorms of Christmas eve, 1912. The organization engineers made their own plans. No only had the organization been successful in spite of the very heavy handicaps of having practically no funds, for, although the cost of the snow-removal in Philadelphia sometimes amounted to several hundreds of thousands of dollars, the city government was able to make appropriations available before the work was done was never over \$250,000—hardly enough to pay for a few hours' work. The balance had to be met during the spring by a deficiency appropriation. No only had the organization been successful from the start but many cities have based their snow removal organization more or less on the Philadelphia plan. Of course, the scope of the work varies in different cities. For instance, while Philadelphia has a snow-removal program embracing over 500 miles of streets, New York city has a program embracing over 300 miles of streets, and every northern city adopts it.

The mayor of Philadelphia invited various northern cities to a snow conference, which was held in that city in 1917. Representatives of sixteen cities were present and their report was presented at the meeting of the American Society of Municipal Engineers in December, 1914. It might be noted that one of the most active participants in the snow conference and one who made some very valuable suggestions as to possible improvements in snow removal practice was a former street cleaning Commissioner of the city of Washington, D. C.

Cost of Plows Slight.

In conclusion, it is suggested that the recent snowstorm in Washington would not have caused anything like the inconvenience it did if there had been a fleet of forty heavy auto trucks, beginning on the evening of Saturday, January 28, and working through the night and following day. It costs comparatively little to equip a motor truck with a plow. The Army, Navy or Post Office might have caused the surplus war materials, of which the War Department has such large stores. The government trucks are operated by the city in large numbers and are under the control of the engineer in charge of the city's snow removal. His jurisdiction as chief co-ordinator of motor transport by the director of the bureau, and therefore, he within the power of the District officials to prepare immediately the snowplow force must be had in that state. Most cities find has solved the most important factor of the problem.

LOWER COURT UPHELD.

Mandamus Sought by Foster

Father of Soldier.

The District Court of Appeals, in an opinion by Chief Justice Smyth, sustained the action of the Supreme Court in denying a mandamus sought by John F. Norris, father of William R. Norris, a soldier in the service of the War Department. After the death of Ricketts Congress amended the war risk act so as to include persons standing in that relation to the deceased, and Norris claimed under the provision. The court held that he was entitled and the petitioner sought a mandamus.

WILL CONSULT HOOVER.

New England Chamber of Commerce Officials Arrive.

Fifty secretaries and presidents of chambers of commerce of twenty and thirty cities in New England have arrived in Washington for a two-day conference with Secretary Hoover. The conference is to be held today and tomorrow. Secretary Hoover will describe the work being done by the bureau of foreign and domestic commerce in promoting foreign trade. The present economic situation with respect to foreign trade also will be discussed.

WILL DISCUSS FORD OFFER

Secretary Weeks to Appear Before House Military Committee.

Secretary Weeks announced today that he would appear before the House military affairs committee Wednesday at 10:30 o'clock to present his report on the contract proposal of Henry Ford for purchase and operation of the military and power projects at Muscle Shoals, Ala., recently sent to the House.

GEN. HARBORD ENDS TRIP.

Maj. Gen. James C. Harbord, deputy chief of staff, who accompanied Col. Fairbank, assistant secretary of war, on an extensive tour of inspection of military posts and stations in the south and west, returned today to his post at the War Department. Assistant Secretary Fairbank, who extended his trip to the northwest, is expected to return to this city before next Monday.

It was said to possess more than 100,000 acres of land in the northwest, and it was expected that it would be a valuable asset to the government.

Polytechnic Institute, where he was a classmate of George R. Putnam, now United States commissioner of lighthouses, including the Chicago and Eastern Illinois, Illinois Central, M. & T. and Mobile and Ohio. A large portion of his work has been connection with important buildings throughout the country. The Condron Company of which Mr. Condron is president, has designed and supervised the construction of more than one hundred buildings, erected in all the different states and Canada. See list of Condron's clients on page 2.

General Electric Company, Sears, Roebuck & Co., Ford Motor Company, Wagner Electric Manufacturing Company, American Book Company, Baldwin Locomotive Works, United States Navy Department, yards and docks and numerous clients less widely known. In 1917 Thomas A. Edison retained Mr. Condron to design and direct the repairs and restoration of the large group of buildings gutted by fire at the West Orange plant of the Edison Company.

Will Construct Great Viaduct. The Condron Company has been retained by the South Park Commission of Chicago to design a two-mile viaduct between Lake Michigan and the city of Chicago, which was one of the most important features.

Called Leader by Col. Keller.

Mr. Condron is looked upon by Col. Keller, Engineer Commissioner of the District, as one of the big men in the engineering profession of this country. He is a member of the American Society of Civil Engineers, the American Railway Engineers' Association and numerous other technical societies.

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