THE

SAN FRANCISCO CONFLAGRATION

OF APRIL, 1906.

SPECIAL REPORT

TO

THE NATIONAL BOARD OF FIRE UNDERWRITERS

COMMITTEE OF TWENTY

By S. ALBERT REED, Consulting Engineer to the Committee

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THE CONFLAGRATION IN SAN FRANCISCO.

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General.—San Francisco, California, a city of 400,000 population, was visited at about a quarter past five in the morning of Wednesday, April 18, 1906, by a series of earthquake shocks of great violence, doing extensive damage. Shortly afterward, presumably as a consequence of the damage done by the shock, numerous fires broke out. It was soon found that the water supply system of the city, rated at 36,000,000 gallons per day, was so badly crippled that no effective resistance could be offered by the Fire Department. A conflagration followed, lasting about three days, and destroyed 2,831 acres, including the greater part of the business section of the city and also a large part of the dwelling district. The property damage was estimated at least four-fifths of the property value of the city and the conflagration may be considered the greatest, as regards destruction, in historic times.

Acting upon the direction of the Committee of Twenty of the National Board of Fire Underwriters, I proceeded to San Francisco and arrived there the evening of April 24th. The investigation conducted was in the nature of an endeavor to select the salient features of the conflagration, from an engineering standpoint, with reference to the subjects of water supply, fire department equipment and building construction, in their bearing upon the matter of the defence of cities against conflagration. Associated with this general study was the specific subject of the future fire protection of San Francisco under the alarming and unusual conditions to which the city appeared to be liable.

Previous Report.—The engineers of the National Board having, in the course of their investigations of the cities of the United States, made in October, 1905, a detailed report upon the conflagration hazard of San Francisco, embodying numerous criticisms and recommendations, it was of further interest to check up and revise the views adopted at that time; and to do this it was necessary to work out the actual history of the conflagration, the conditions after the earthquake and before the conflagration had fully developed and the situation after the fire was over. While it was realized that a complete investigation and adequate report on so great an event could not be properly covered during a short visit, still it was regarded as important to make an early reconnaissance before repairs had been begun which might obliterate some of the most important and instructive effects of the shock and fire, and to make as early a publication of the results as practicable. It is, therefore, as a somewhat general, rather than as a minutely detailed survey of the subject, that this report is presented. An accurate estimate of the percentage damage done to partly damaged buildings will not be known until the insurance adjustments are completed, and no effort is made in this report to anticipate such results.

Scope of Investigation.—The immediate breakdown of the water distribution system in all but the more remote Western dwelling section produced entirely abnormal conditions from a fire-fighting standpoint, and reduced the contest to a series of forlorn-hope stands on the part of the Fire Department, with more the character of a massacre than a battle. For this reason the interest of the event to the science of fire defense is less, in a certain sense, than it was in the case of the Baltimore fire of February, 1904. There were, however, many facts of interest with a bearing upon the subject of conflagrations under more normal conditions. One was the conduct of the different classes of buildings, notably the so-called fireproof structures, under circumstances which were much the same as those attending 27 similar buildings in Baltimore. Another incident, familiar in other conflagrations was the successful defense made by occupants in buildings either specially fortified for fire resistance or not so fortified; but, in both cases, furnished with independent water sources of greater or less extent. It was also important to observe the results obtained from the very extensive use made of explosives.

Character of Earthquake Damage.—On the solid ground the action was confined to shaking, in which the upper parts of structures were apt to experience a maximum oscillation. In soft ground there were permanent displacements which resulted in a distortion of the lower parts of structures where foundations did not go through to sound ground. This is illustrated by the cases of the Aëtna Building, the Post Office and the car tracks at the foot of Market street, all of which were on foundations going through the few feet of soft material. They show but slight change of level, although the streets adjacent have sunk away. The damage
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from shaking was seldom ruined except in top-heavy structures, whereas that from displacement was generally structurally destructive. Damage, therefore, was to be looked for on solid ground only to buildings which were top-heavy, without vertical continuity, but in the districts where soft ground prevailed all classes of buildings would suffer except those whose foundations went sufficiently deep. As the buildings with deep foundations were few, the region of displacement included far the larger proportion of serious damage of all kinds, not only to buildings but to water, gas and sewer pipes. This displacement region coincided mainly with the boundaries of old filled land lying east of Sansome street and south of Mission street, where the filling was frequently sand on mud. There were also local displacement effects in the uplands in the northwestern part of the city. The displacement effects in the soft, low lands were evidently caused by a slipping around of the soft material with a puckering up in some places and thinning out in others. In the uplands the displacement effects were even in the nature of vertical drops and breaks, sometimes of several feet, and appear to have been caused by flowing of the sand.

Extent of Earthquake Damage.—The actual damage, though appalling to those who experienced the shock, was not as a general rule, structurally serious as far as appearance went. Apart from buildings having ponderous architectural attachments, particularly the City Hall, where the damage was great and spectacular, the apparent structural injury was mainly to tall chimneys, church towers, and unbraced brick gables, copings and projections. Interior plaster, tiling and adhesively applied decoration were quite generally wrecked. House chimneys above roofs fell extensively. Actual collapses were mainly confined to flimsy, frame structures. Observation of the unburned western addition and also of photographs taken between the earthquake and the fire make it clear that San Francisco was far from being destroyed by the earthquake and that outside of small districts in the flats it was the exception that a building was rendered uninhabitable. The effect on fireproof buildings was especially important, as the steel frame type had never before been seriously tested in an earthquake. It may be said, generally speaking, that these buildings had no apparent structural injury. The steel frames appeared plumb and true, and, contrary to the early account, neither the sides nor the floors had dropped out. Cracks appeared in many instances, especially X cracks in pilasters built around exterior columns. The early accounts, stating that side walls had dropped out, probably arose from the fact that there were several tall and conspicuous steel frames in course of construction which had not yet received their side walls. Furthermore, at the City Hall a lofty architectural mass of cast iron and stone was grouped around a steel frame dome, and the fall of the general mass left the steel frame of the dome exposed. Non-apparent injury to steel frames and their exterior walls occurred to a considerable extent, due to straining. In wooden frame buildings it was noted that where each story was framed to that below unless diagonally braced the damage was greater than where the verticals were continuous, as in the balloon frame of less repute. In fact, immunity from effects of the earthquake seemed to be a characteristic of buildings having vertical continuity, as distinguished from vertical discontinuity. In steel frames, where each column is spliced to that below, column tiers are practically continuous. Buildings depending mainly upon gravity for their stability experienced the maximum injury. The ordinary brick wall has slight continuity apart from gravity aided by the bracing effects of the beams, unless the brick is properly laid in cement and properly bonded and the walls of more than usual thickness. Such walls in the latter were rare in San Francisco. Still, even in the case of weak walls, the interior bracing reduced structural damage where there was no actual ground displacement. There were, however, a large number of structural injuries, not apparent to the eye, but such as would have required expensive repairs had there been no fire.

Water Supply and Damage to Same.—In order to understand this subject it is proper to summarize briefly the conditions of water supply as reported by the National Board Engineers in October, 1906.

Water was supplied by the works of a private company, viz., the Spring Valley Water Company. The sources were watersheds to the south of the city, collected in three storage reservoirs and conveyed in three supply conduits each to a separate distributing reservoir within the city limits. These three distributing reservoirs, viz., the University Mound, the College Hill and the Lake Honda, supplied by gravity, respectively, three services, viz., the first, second and third, each at a different level, there being a great variation in the city's topography. There were also two small high level services, the fourth and the fifth, supplied by direct pumping from the mains of the first and third services. The three services and the damage done to each by the earthquake may be stated briefly, as follows (see also Plan No. 3):

First Service.—Supplied, at an average pressure of 49 pounds, the low level, business and tenement district south of Market street which was largely made and alluvial ground. The gridiron cast iron pipe was supplied through a 44 inch riveted wrought iron main on Harrison street from the University Mound reservoir of 33,000,000 gallons capacity. This was supplied from the Crystal Springs storage reservoir through 17 miles of 44 inch wrought iron conduit passing partly through swamp land and in seven places being carried on wooden trestles 300 to
3,000 feet long. The damage done to this system was extensive. The Crystal Sprin storage reservoir was intact in spite of the fact that it had a concrete dam 115 feet high. The 44 inch conduit suffered extensive damage, mainly in the portion crossing the marsh north of San Bruno, where over 1,300 feet in length was wrecked. It required three weeks' work to repair this damage and to restore the flow. The University Mound distributing reservoir was not injured. The distributing mains of the first service had a series of breaks in the neighborhood of Seventeenth and Howard streets, and there were also numerous breaks in the minor distributors all throughout the district covered by the first service. At the extreme northern end of the city the supply main of the first service terminated in the Francisco street equalizing reservoir, which supplied the manufacturing and warehouse district near the water front. This reservoir had a capacity of 6,000,000 gallons and was not injured by the shock. Near this point the mains of the first service also supplied the Black's Point pumping station, which pumped water into high service tanks supplying what is known as the fourth service. These tanks were, first, the Clay street tank, 200,000 gallons, supplying the high-class residence district near the Fairmount Hotel; second the Presidio tank, 700,000 gallons, supplying the Presidio at the northwest end of the city. The fifth service, in a thinly settled district in the southwest part of the city, was supplied from the first service by pumping to the Clarendon Heights tank. Although the Crystal Springs conduit supply was cut off, the University Mound distributing reservoir, with three days' supply, was intact. This large supply, however, was useless on account of the extensive break-downs scattered throughout the distributing service, to which should be added also the numerous breaks in house service branches caused by the wreck of buildings, which wrecks were most numerous in the district of the first service. Most of the original fires were also in the first service district. The Black's Point pumping station and also the Francisco street reservoir had their supply cut off. The latter, therefore, together with the two tanks of the fourth service, though not damaged, could only furnish their districts with their own reserve supply naturally limited under the draft which followed.

Second Service.—This service supplied, by gravity, the greater part of the congested district to the north of Market street, with an average pressure of 52 pounds. The distributing mains of cast iron pipe were in sound ground at a somewhat higher level than the first service; but the two cast iron supply mains, one 24-inch and the other 30-inch, led through a low tract of made land on Valencia street near Eighteenth street. This service was supplied from the College Hill distributing reservoir of 15,000,000 gallons capacity, which, in its turn, was supplied from the San Andreas storage reservoir through nearly 14 miles of wrought iron conduit, mainly 44 inch, 37 inch and 30 inch, with a half a mile of brick lined tunnel. This conduit was in solid ground. The damage to the street mains in the second service was not extensive; but the two supply mains on Valencia street were crippled by an extensive break where the mains crossed the low swampy tract near Eighteenth street. The College Hill reservoir was not injured, nor was the San Andreas storage reservoir. The conduit connecting the two was broken at a slip joint on the Baden trestle, but was repaired by the end of the week. There was also a break in a main leading from this conduit at Capitol Avenue and Sagamore street supplying a small suburban district.

In spite of the fact that the supply sources of this service, viz., the storage reservoir, the conduit and the distributing reservoir (the latter with three days' supply), were practically intact, the service was rendered useless on account of the extensive breaks on Valencia street, which required a week to repair. The breaks in the second service system had been sufficiently repaired by May 1st to enable water from Crystal Springs reservoir to reach the Black's Point pumping station through the connections with the first service mains at Second street. None of the original fires were in the second service district, which included the valuable and important district around Union Square. About a half a day elapsed before extensive drafts on the second service were needed, as its district was not involved in the conflagration until toward evening of the first day. Partly successful efforts were made to supply engines by gate valve manipulation between the third and fourth services, and the second service, so long as the third service had water to spare.

Third Service.—The distributing reservoir was Lake Honda, 31,000,000 gallons capacity, supplying the residence part of the city, largely a frame district and at a level higher than those of the first and second services, with an average pressure of 61 pounds through four cast iron supply mains, 16 inch to 30 inch. Lake Honda was supplied from the Pilarcitos storage reservoir by about 16 miles of conduit, about 1% miles of which was wooden flume and the rest partly cast iron, partly wrought iron pipe and partly brick tunnel. The Lake Honda reservoir was damaged by the earthquake to a moderate extent, an extensive crack having developed. The reservoir still held water up to a certain level, and, as the main arteries leading into the city were not damaged, this residuum in the Lake Honda reservoir was the city's main supply during and for a week after the conflagration. This crack was repaired in a week's time. The conduit from Pilarcitos storage reservoir to Lake Honda was disabled by extensive breaks over a distance of 6 miles, south of Frawley's Gulch, by the entire destruction of trestle crossing the lat-
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ter and by other breaks farther north. The line of this conduit appears to have been unfortunately chosen, for, though it is on solid ground, it is apparently near an extensive fault line running northwest and southeast through the country. The Pilarcitos reservoir, in spite of its earth dam, 95 feet high, was uninjured. The third service supplied at the extreme north end of the city the Lombard street equalizing reservoir of nearly 4,000,000 gallons capacity; also the Potrero equalizing tank, in the southeast quarter of the city not reached by the fire. The third service was heavily taxed during the conflagration and there was also a heavy earthquake break at Vallejo street, and although during the first day working streams were obtained for the hydrants, during the following days when all the eastern part of the district supplied by the third service was destroyed, the bleeding of the system made it necessary to cut off these portions and to deprive the Lombard street reservoir of its supply. On the second day, however, hydrants on Van Ness avenue as far north as Ellis were being used and the Buchanan street hydrants were continually in use. The Lake Honda reservoir, though unable to get water from the Pilarcitos conduit, after a time was replenished by pumpage from Lake Merced, a supplementary supply whose injuries from the earthquake were repaired within 24 hours.

Water Supply After Earthquake.—The supply system outside the city was thus reduced to three uninjured storage reservoirs and only one uninjured conduit, viz., the San Andreas. Means of inter-connecting the three storage reservoirs existed uninjured and the present supply at this writing is limited only by the capacity of the San Andreas conduit and by the pumpage from Lake Merced, which supplies are ample for the small part of the city still remaining. The University Mound reservoir was almost empty about May 1st, no water having reached it; but two weeks later it was being gradually filled, the College Hill reservoir was full and the Lake Honda almost ready to fill completely. The San Andreas reservoir was being used as a distributing reservoir for the city. A new pumping station was about to be installed at Twenty-sixth and Harrison streets, to supply the University Mound reservoir from the San Andreas conduit.

Supplementary Supplies.—There were also two supplementary water sources from which water could be pumped into the three regular conduits. These were:

First.—The Alameda, which supplied water from Alameda Creek on the eastern side of San Francisco Bay by a 27 mile conduit, wrought iron, wooden flume, submarine pipe, tunnel and wrought iron pipe, nearly 4 miles of the latter being on wooden trestle. The conduit led to the Belmont pumping station, which pumped thence into the Crystal Springs conduit through 7 miles of wrought iron pipe. This supply and its conduits appear to have been uninjured on the west side of the Bay, but injured on the east side.

Second.—Lake Merced, which is a natural lake near the city limits and from which a supply of water could be pumped into Pilarcitos conduit. This system was injured, but was repaired in 16 hours and the saving of the western addition was probably due to the 7,000,000 gallons thus supplied.

The Water Company was for some weeks deprived of all its maps and records by the fire. Out of 4,211 hydrants 1,500 were put out of order. As late as June 15th broken service pipes were still wasting half of the total city supply. The following two minor water supplies were also reported by the National Board Engineers in October, and are of interest.

Additional Supplies.—First, 23 fire cisterns, having capacities of 16,000 to 100,000 gallons, survivals from earlier days. Their locations are given on the Plan No. 1. They were of brick, with bottom 20 feet and top, or dome, 2 feet below the street level; entrance being through manhole. They were maintained by the Fire Department, being filled from the street mains. These cisterns appear to have survived the shock and were generally made use of by the Fire Department, in some cases with useful effect. Acting Chief Dougherty stated that the check of the fire at the southerly border in the Mission street district at Twentieth street was mainly due to the cistern at Twenty-second street and Shotwell street. Similarly at Vallejo and Dupont.

Second, Olympic Salt Water Company's 12 inch pipe line, leading from the western shore into the heart of the congested district, with 28 street hydrants, supplied by pumpage to a 6,000,- 000 gallon reservoir, with 30 pounds pressure in the mains. The pump-house was wrecked in the earthquake by fall of the chimney. The reservoir was uninjured and also the main as far as the baths at Bush and Larkin streets, and at least up to Market street, since Acting Chief Dougherty stated that he used the hydrant at the corner of Fifth and Market streets and got a good stream. This is probably the stream shown at work in Fig. 43.

There were also wells in various parts of the city, such as Center's at Sixteenth and Polkson.

Defects of System.—The existing water system, as a whole, was a good one; but the distributing pipe system was criticised by the National Board's report in October, inadequately meeting the probable draft during any fire of character approaching that of a conflagration. It was shown by exhaustive hydrant and engine tests that at that time at important points in the congested district only a limited number of engines could be supplied with water without a reinforcement of the supply by opening gate valves from the higher services. Thus the maximum delivery was at Market and Second streets, where it was found
that only 13,000 gallons per minute could be furnished by the first service, which could be increased to 19,000 by opening valves and admitting water from the second service; whereas the standard recognized by the National Board stipulates not less than 20,000 gallons per minute over and above the maximum consumption, as a minimum for supplying a sufficient number of engines. At other important locations in the congested districts the supply was far less. It is, therefore, quite certain that even without disablement of the supply the Fire Department would have found itself hampered for lack of water in the presence of even half a dozen simultaneous fires.

Projected Water Supply.—A separate high pressure fire main system, with salt water auxiliary supply, was under consideration before the fire.

Structural Conditions.—San Francisco was 90% frame, a larger proportion than that in any other city of its size in the country. The fire limits for frame buildings approached unusually close to the business section, and the congested district itself included 30% of frame buildings of older date. Frame buildings of a considerable height, 4 to 5 stories, were common. The dwelling district was almost entirely frame, large sections being not scattered, as is usual in frame dwelling districts, but in compact blocks. Market street, 120 feet wide, running northeast and southwest, divided the city into the level district south, and the hilly district north. In the latter Van Ness avenue, 125 feet wide, running north and south, divided the older residence part from the newer Western Addition. In the congested district 75% of the streets were 60 feet and over in width, and about 30% were 80 feet and over. Construction was generally poor in the older buildings; but better methods were followed in more recent construction. Buildings other than frame were classified, under the building law, into class A, fireproof, class B, wooden joisted brick with metal lath, and class C, wooden joisted brick with wooden lath. There was a height limit for each class, viz., class A, 220 feet; class B, 100 feet; class C, 82 feet; frame buildings 45 feet. The permission thus allowed for wooden joisted brick buildings to be carried up to 8 stories, provided they had wire lath and plaster ceilings under the joists, indicated an amount of faith in that type of protection not generally shared by underwriters.

Fireproof Construction.—There were, at the time of the fire, about 54 fireproof buildings in the city, 6 of these being in course of construction. Heights, including those in course of construction, were: 5, 15 stories and over; 14, 10 to 12 stories; 5, 8 and 9 stories; 18, 4 to 8 stories; 10, 3 stories and less. Buildings with floors of mill type were 2 outside the business section; 2 of modified mill type in the business section.

The National Board Engineers reported about 50% of buildings shuttered, generally non-standard and with front openings seldom protected. They also criticized the lack of protection to wall openings in fireproof buildings. The same criticisms have been found applicable to most cities in the country and have apparently been justified in this event.

Fire Outbreaks.—It is difficult to determine the number and location of the original fire outbreaks and their causes. The first shock was at 5:13 1/2 A.M., at which time there was daylight in the streets; but the moment was naturally one of panic, and, apart from the actual effects of the shock, there was, for a time, uncertainty as to whether other shocks, still more violent, were not still to come. The fire alarm headquarters were in a brick building on Brenham place, the intention being to remove soon to the City Hall. The offices were wrecked by the shock, there being but two working lines left. The batteries were thrown down and a fire occurred which was extinguished. Later the conflagration reached and destroyed the premises. The Chief Electrician reports no alarms. The telephone system also broke down over a considerable district and doubtless many unsuccessful attempts were made to send in alarms. The city had no automatic alarms. From accounts of eyewitnesses, rather than as a matter of record, it is learned that within a few minutes after the shock several fires were visible. It is said that about 50 were burning by 8 A.M., but it is probable that not over a dozen had developed during the first half hour which were original fires.

Local Distribution of Outbreaks.—There is little doubt that all the original fires were south of Market street and east of Sansome street, with the exception of one west of Van Ness avenue and north of Market, at the corner of Howard and Laguna streets. This predominance of the original outbreaks in a quarter characterized by soft ground coincides with the predominance of structural injuries to buildings and of breaks in water, gas and sewer pipes in the same district. This district was also that in which there appears to have been the greatest loss of life.

Electrical Fires.—Rocking effects might occur without fracturing the house connections of electrical and gas services; but displacement effects could hardly have failed to produce fractures inside of the house lines. Some crosses occurred of the 550 volt trolley wires with other wires from the falling of portions of walls across them. South of Howard street other high voltage overhead wires existed. It seems to be clear that the electric service current was not shut off for some minutes after the shock. In Oakland, where the earthquake damage was mainly of the rocking and but slightly of the displacement character, the earthquake damage was about on a par with that in
San Francisco outside of the displacement district, and the Oakland electric current was shut off more promptly. These two facts may account for there having been only one outbreak of fire in that place. It is possible that National Code Standard service cutouts would have fused safely and protected the buildings in which they might have been installed.

Stove and Lamp Fires.—There were several manufacturing establishments in this district, in which banked fires were kept during the night under boilers. There were, also, at this hour of the morning, fires being started and kerosene lamps burning in lodging and tenement houses, restaurants and hotels of the cheaper class, which were numerous a few blocks south of Market street and which are known to have experienced extensive damage. Among the buildings in which fires are known to have originated are a frame restaurant on Mission street, between Fifth and Sixth, a large wholesale grocery brick warehouse, on East street, a short distance north of the ferry, and the Terminal Hotel at the foot of Market street. North of Market and east of Sansome was a market and produce district which was already active at this early hour, probably with the use of gas and other lights. Some serious collapses of buildings took place in this quarter, easily accounting for original fires.

The most serious earthquake collapse so far as regards loss of life was the frame Valencia Street Hotel near Eighteenth street. No fire originated there, however, the ruins being burned later by spread of the fire from other places.

Miscellaneous Causes.—Many such will occur to anyone as likely to have been responsible for original fires. One is related as occurring from the ignition of matches by the overturning of furniture, the fire having been extinguished by the occupants.

Structural Conditions at Points of Outbreak.
—The brick built district extended not more than two or three blocks south of Market street and the district beyond was almost wholly frame. The frame feature, of course, greatly facilitated the rapid spread of fire; but there is only slightly greater liability to interior fires in a frame than in a brick building and the development in the brick building may be quite as rapid.

Response of Fire Department.—In October, 1905, the National Board Engineers reported the total fire force, including reliefs, as 585 men, all full paid; 38 engines, 15 in reserve; 10 ladder trucks, 3 in reserve; 7 chemical engines, 2 in reserve; 1 water tower, 2 in reserve; 2 batteries, 2 in reserve: 76,700 feet leading hose; no fire boat, but 2 fire tugs maintained by the State Board of Harbor Commissioners. One of these tugs had a capacity of 1,400 gallons and the other of 930 gallons per minute, both against a water pressure of 150 pounds; and they had a total of 1,100 feet of 3 inch hose. The Fire Department was considered efficient. The Chief of the Department, D. T. Sullivan, was disabled by the wreck of Chemical Engine House No. 3 on Bush street, where he was sleeping. He was taken to hospital and afterwards died. His duties devolved upon Assistant Chief John Doherty. No engines were seriously disabled by the earthquake and all went into service. The lack of regular means of communication and the absence of water in the burning district made anything like systematic action impossible; but it is quite likely that during the early hours of the fire the result would not have been otherwise, even had none of these abnormal conditions existed. It would at least be doubtful if even in New York a dozen simultaneous fires could be successfully suppressed if scattered through a territory a mile long and a quarter of a mile wide, in spite of the fact that New York could concentrate more than three times the amount of apparatus at the points of danger. After the fire the Department reported to have lost three engines, 1 ladder truck and 2 batteries; 12,100 feet of hose 2½ inches to 3 inches; besides 16 engine houses burned and other extensive damage. It thus appears that more than half of the Department's hose was lost in the fire. One engine, wrecked by a falling wall, was seen after the fire to the east of the Slocam Building on Post street. Besides the Chief, the total casualties consisted of one fireman killed at the house of Engine No. 4, Third and Howard street, and one man injured.

During the early hours of Wednesday the wind was generally light from the west, carrying the fire away from Market street and Sansome street into a territory of low, strung-out blocks, bounded by the Bay. Judging from the successful work which was done during this period on fires which occurred in places in the third service, where some water could be obtained, and having in view the lightness of the wind and its direction, it is a reasonable presumption that had water been abundant the Fire Department might have obtained control by noon of the first day.

Progress of Conflagration.—It is not easy to map out accurately the progressive history of this conflagration; but an approximation is given in the Plan No. 2, in which the conditions are given during four different periods of the total three days. These periods are of uneven length; but each, to a certain degree, was differentiated from the others by individual characteristics.

Wind.—The Weather Bureau was installed in the Spreckels Building, which was burned out about noon on the first day, and the official records terminated at that time, and were not resumed until April 20th. The wind directions during the three days of the fire have therefore been ascertained from non-official sources. Up to noon on the 18th and after 4 P.M. on the 20th, the official records are:
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April 18. Time. Direction. Miles per hour.
5 " 6 A. M. S. W. 2*  
6 " 7 " W. 2*  
7 " 8 " W. 4  
8 " 9 " W. 5  
9 " 10 " W. 10  
10 " 11 " N. W. 12  
11 " 12 " W. 19  

April 20.  
4 to 5 P. M. W. 26  

April 21.  
4 to 5 A. M. W. 10*  
4 to 5 P. M. W. 20*  

* Estimated.

As a control on the directions assumed for the 52 hours of which local records are missing I quote the wind records at neighboring cities for the four days, viz.:

April.  
18th. S. E. light E. light W.  
19th. E. light N. E. 6 W.  
20th. S. W. light N. E. 10 W.  
21st. S. 8 N. E. light W.

First Period.—The first period is taken as extending to late on the first day. It will be noted that but one original fire occurred at the time of the shock outside the district south of Market street and east of Sansome street. This was a two-story frame building corner of Hayes and Laguna streets, which was easily distinguished by the firemen, there being water from the third service available at this point. Sometime after the shock another fire started in a frame building, corner of Hayes and Gough streets, said to have been caused by making a kitchen fire in a stove with a wrecked chimney. This fire was not brought under control and was apparently responsible for the invasion of the district north of Market street. It was a windward attack and resembled a successful flank turning operation. Figs. 13 and 14 illustrate these two fires. The spread of the fire during the first period was apparently not in the nature of a fierce sweeping blast. The heated column evolved was not sufficiently deflected fromac the vertical to produce long range effects, nor to exercise a reverberatory action on roofs, nor to attack openings by actual contact. Apparently there was a spread from building to building with a great variety of individuality in different places and with only a moderate leeward tendency. The ordinary rules of exposure seemed to have prevailed and the leading part was played by the familiar factors, individual combustibility, adjacency, opposing openings, short distances and excess height. As is usually the case with exposure fires, the vulnerable points in brick buildings were the glass of windows, the wood of window frames, the skylights, the boards of roofs covered only by a thin sheath- 

ing of metal or other material, and the combustible cornices and roof structures of various kinds, while distant ignition appears to have been largely by brands. Radiation effects in this period seem to have been limited and there was evidently no extensive front unapproachable within several blocks. This is well illustrated by Figs. 23 to 28, where the individuality of the fires in the early hours of Wednesday is well shown. It is true that these photographs are all necessarily from the windward position; but the experience of Engine No. 3 is an illustration of the fact that the fires were not unapproachable. This engine, being unable to get hydrant water, took suction from the cistern at First and Folsom streets, and successfully protected the buildings at that corner, directly in the lee of the conflagration. They then strung a long lead of hose from the bay and succeeded in holding the large Folger Coffee & Tea Warehouse, a building of ordinary construction with joisted floors and unprotected openings. They also saved the two-story hardwood warehouse opposite. These two properties represented large values. This engine had difficulty from the use of salt water in its boiler; but its operations were attended with success. The surrounding blocks were of low scattering character and the Department evidently had mainly ordinary exposure conditions to contend with and not a long range conflagration sweep. As the leeward spread approached the water front, both above and below Market street, it experienced a vigorous opposition from the fire apparatus of tugs and vessels. The Acting Chief directed the use of the State Harbor Commissioner's tugs to a certain extent, a Navy tug, a revenue cutter and independent vessels furnished aid and throughout the entire three days an incessant and obstinate battle was waged along the water front as far inland as lines could be laid. For the first day this water front was on the lee of the conflagration and in places the pier structures were so large as to absorb all the efforts of the fire fighters and leave little margin for working further inshore. It is probable that the fire reached near the southern boundary mainly during the first period. The southeast limit was defined by two causes, first, the thinning out near the Southern Pacific yards, and, second, by the water supply from the Mission Creek channel, running a mile inland, furnishing water for engines. A successful stand was made at the warehouse group near the (57—Plan 1) S. P. R. R., and also at the Pacific Hardware Company (58—Plan 1), corner of Seventh and Townsend. The latter, which was a large, modern, two-story automatic sprinkler equipped warehouse, with mill type floors, lost its elevated tank and some of its wall coping by the earthquake and had no window protection. It profited by the scattered, low height blocks to windward and by a southerly slant of wind at the time when
the fire reached it, which was during the second period. The plant was not abandoned by its employees during the fire, though little water was obtained. In the district north of Market and east of Sansome streets during the first period caused a sweep eastward to the Bay; but practically no progress was made to windward. The most remarkable instance, during this period, was that of the California Electrical Company's factory at Third and Folsom streets. This was the Western Electric Company's Pacific Coast factory and manufactured electrical supplies; it was a four-story brick, mill construction plant, with automatic sprinkler equipment; 50,000 gallon tank, elevated 30 feet, 120,000 gallon covered yard reservoir, electric pump supplying tank, yard and private street hydrants. They also had an equipment of private hose. The current for the pump having failed, the latter was useless. All windows except a few on the fourth floor front, which had iron outside shutters, were protected by wire glass in metal frames, automatically closing. Although some of the mill coping fell, the tank remained; no sprinklers operated. Hose service was useless on account of lack of power, but the employees stood their ground and fought off the exposing fires with pails of water. The first day's fire was on the north and east, and a more severe attack occurred on the south and west on the second day, with very hot exposure on the west, so that cases of ignition occurred through the wire glass windows. The factory was saved and resumed business when the fire passed. It had been only recently erected and was the only plant in San Francisco constructed and equipped up to Factory Standard, corresponding with the standards of the National Board of Fire Underwriters for self-protecting factories. It is illustrated in Fig. 116-117.

The next notable case of defense was that of the U. S. Mint, which lasted through the greater part of Wednesday. This was a building with wooden roof, although with old style iron beam and brick arch floors and granite walls. The window protection was limited to the first and second floors and was far from modern standard, being merely inside folding iron shutters, whereas the third floor windows were of ordinary glass and wooden sash. There was an independent water supply with pump, limited and inferior in character. Supt. Leach, however, held his men together, and, assisted by Lieutenant Armstrong with some regular soldiers, made a successful defense, which, considering the vulnerability of windows and roofs and the severity of the windward exposure on the north, as evidenced by the heavy spalling on the granite walls (see Fig. 114), was very commendable.

The next notable case was that of the Post Office, which was of modern fireproof construction, three stories high, and was saved by employees, extinguishing, in detail, window frames, furniture and interior of rooms, attacked through windows broken by the heat. The water used was from their own well and the apparatus was mainly buckets. The exposure was moderate, a one-story frame, and the fireproof Grant Building being the nearest. Only a portion of the third story interior at the north corner was burned out. The defense of this building was very creditable.

Up to late Wednesday afternoon Market and Sansome streets, as far north as Broadway, were the northerly boundaries of the fire. The wind was still blowing moderately from the west and the financial district near California street, the modern retail and club district, around Union Square, and the hotel, apartment, and theatrical districts, to the south and west, seemed to have a chance of escape in spite of the absence of water. The fire burned away the buildings in the lee of the Appraisers' Bldg., which was also protected by a vacant lot where the old Post Office had been recently torn down. There was a 6,000 gallon roof tank and an artesian well and close economy of water was exercised by Appraiser Dare, who held together a force of employees, assisted by U. S. Marines, sailors and soldiers. In the vacant lot an excavation existed containing a quantity of tide water from the Bay, which was of some assistance. The Custom House was a three-story building with old style iron beam and brick arch floors and wooden frame roof, without protection at the windows; but its defenders extinguished, in detail, ignition fires at the windows and on the roof, until the leeward exposures were burned away. There was no exposure on the north and west until the third day; but the defense of the Custom House undoubtedly prevented the fire working to windward and saved the blocks to the west and north. On the third day the building had a more serious attack from the north, which was fought off in the same way, the defending force extending their efforts also to saving the blocks on the north and west, in which efforts they were successful. The United R'ws Power House at Bryant and 13th was saved by employees using private salt water supply. (No. 59.)

Excepting the salt water hydrant stream, at Market and Fifth streets, and the cistern supplies, mentioned before, all the burned and directly threatened districts were practically without water, although cases are given where engines got water from the sewers, which were in some places carrying off the wasteage from broken mains. Original fires did not occur to any considerable extent in buildings fronting on the south side of Market street. Mission street, the first street parallel on the south, had a number of original fires and the entire street was gradually involved; so that the spread to the buildings on Market street was in the nature of a windward and side spread aided by frequent veering of the wind to the southwest. The spread of the fire to the buildings on the south side of Market street is admirably illustrated in Figs. 34, 35, 36.

The Emporium Department Store was ignited through rear and unprotected windows by
the intense heat from its Mission street warehouse. The 21-story Spreckels or Call Building, in excellent condition after the shock, ignited through broken windows on the fourth floor early in the afternoon, from fires in the small frame buildings in the rear and in the annex on the west. The Fireproofs, Åtna, Rialto, Aronson, Kamm and Wells-Fargo, had been abandoned and were gutted. The Palace Hotel ignited from the rear and side streets. This hotel was a wooden joisted building of unusual construction, designed especially to withstand earthquake shocks. Its special feature of construction was the massive exterior and cross walls, the latter sectionizing the building from cellar to roof into cells of moderate area, the cross walls being tied to the exterior walls with iron rods in the masonry. There was no protection to the openings between the sections. Practically all beams were wall supported without columns or girders. The masonry was of superior character and the net result, both as to earthquake and fire damage, was a justification of the design and important as showing that the steel frame is not the only type which may be safely adopted to meet the local conditions. The building as a structure was but slightly damaged by the shock. Some wreckage of interior finish was caused; but guests who chose to return had breakfast at the hotel. Being a wood-joisted building, with extensive wood frames at the window openings, it was of course doomed to be reduced by fire to its walls only; but, as shown in Fig. 122, these are to all appearances intact and it would, apparently, be possible to replace the floors and restore the building. There was a good attempt made by the occupants to defend this hotel. They had an independent well and pump and a considerable equipment of fire apparatus; but the defense of a hundred or more closely attacked and unprotected wooden frame windows and a vulnerable roof, naturally swamped the defenders, so that early Wednesday afternoon the hotel was abandoned to the flames, as shown in Fig. 42. In this way the fire steadily worked into the entire south side of Market street; the north side, however, west of Sansome, appeared to have more than a chance of escape. Early in the forenoon of Wednesday began the extensive use of explosives which figured so prominently in this conflagration. A considerable number of heavy blasts had been fired in the business district south of Market street during the morning, which is to be noted as indicating the remarkable accessibility of this district, in spite of the large fires raging in it. There was no intelligent plan in the choice of locations. Attempts were made on steel frame buildings and selections were made of buildings adjoining those which were burning. An instance is that which resulted in the injury of Police Captain Gleason. On his own discretion, with the assistance of a U. S. Army Lieutenant and some soldiers, he attempted to blow up a small saloon north of a six-story brick lodging house, corner of Sixth and Mission streets, hoping to check the spread of fire towards Mission street. Barrels of powder were used and a delayed explosion resulted in injury to the blasting party. The case is mentioned as illustrating the fact that discretion in selecting the locations of explosions was left to a police captain. It is not surprising that men reduced to helplessness by the lack of water should have resorted to what has been proved in all modern conflagrations to have been useless and, in the opinion of prominent fire chiefs and experts, even harmful. As is usually the case, the use of explosives made no reduction in the quantity of combustible material and no effective gaps were made; whereas windows throughout the neighborhood were shattered and the proximity of exploding buildings made it dangerous or impossible for owners or occupants to prosecute individual efforts to protect their own property. It is quite probable, however, that the final result would not have been any less extensive even had explosives not been used.

**Second Period.—** The situation, when Wednesday night came, is important to realize. So far, the rich business district north of Market street, also the high class residential district, were untouched. The wind was still from the west and, though it had veered so as to blow more from the southwest and had risen somewhat since morning, was still not strong. A stand was being made on Market near Gough street, undoubtedly the correct strategic point, as it headed off a flank attack upon what was left of the burning city, and at that point alone was there a working supply of water from hydrants of the third service. It was still possible to maintain communication and to conduct organized efforts, inasmuch as the centre of the city was still habitable. But men were exhausted; questions of life saving became paramount to that of property saving, and everything depended upon the direction of the wind. Should it hold from the west, the Market and Sansome street line might be preserved as a limit. During the evening, however, the wind veered so as to blow more from the south and it increased to a degree which sufficiently leveled the sweep of flame so as to render leeward positions untenable. During the day two Oakland engines were sent over, but returned soon, as it was found they could be of no use on account of lack of water. It is probable that Market street, although 120 feet in width, was crossed directly at some point; but the main invasion seems to have been from a region to the west of the City Hall, north of Market, which invasion made a rapid flank attack, and is said to have been from the previously mentioned original fire at Hayes and Gough streets, starting about 11 A. M. The most conspicuous event at this point, in its moral as well as its physical effect, was the burning of the huge frame Mechanics' Pavilion, a short dis-
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tance S. W. of the City Hall. The effects were now of longer range and the upslope to leeward towards Russian Hill increased the vulnerability of the district. The spread was rapid and the fire raced during the evening through the theatre district on O’Farrell street and into the large retail houses on the south side of Union Square, embracing also the north side of Market street. This district also included the older hotels, of poor construction, the large clubs, all of joisted construction, and many stores and apartments, some of the latter being frame. Higher buildings, like the Crocker, got the blast in their upper stories and caught ahead of their time. The resistive powers of the fireproof buildings, the Mills Building and the Merchants’ Exchange, had served to limit a leeward spread during the day; but during the evening and towards midnight these buildings were also reached by attack from the south and west and were involved with the rest. East in the direction of a widening and easterly windward of this sweep had got into the very vulnerable flame dwelling district on the southwesterly slopes of Nob Hill and had swept up and over it. A vigorous though futile stand was made at the fireproof Fairmount Hotel. Acting Chief Dougherty strung from the foot of Mason street a 34-mile length of hose, which was fed by the pumps of a revenue cutter. Most of this hose was afterwards lost by the northerly spread of the fire. Assisting the Fire Department at the Fairmount were Lieut. McMillan of the “Bear” with U. S. sailors and soldiers, but by morning it was seen that the hotel and all the surrounding high class residential sections had been involved and that the west and north sides of Union Square were burning, including the Fireproofs, Spring Valley Water Co., St. Francis, Shreve, Sloane, Bush Street Telephone Exchange, Hotels Alexander and Hamilton, Bullock and Jones Building and four unfinished steel frame buildings. Farther northeast the Hall of Justice, badly wrecked by the earthquake, caught early Thursday morning. This building had brick and stone bearing walls, steel frame and tile arch floors, and was deserted during the fire. The steel cells on the fifth floor fell through to the basement. Fire cleaned out the combustible interior of all but the north side, where rooms remained in habitable condition, and a large part of this building survived structurally. During the morning the wind had lightened and soon after turned its direction and blew from the east; but, meantime, Chinatown had been reached and during the morning was wiped out. Further to the east the early morning fire had swept up through the frame district between Russian and Telegraph Hills, leaving untouched another part which was involved in the return fire which followed when the wind changed.

Third Period.—The east wind came in time to check the further advance to the Bay and to insure the safety of the Appraisers Bdg. and its westerly neighbors, as well as to check the rapid advance which threatened the Ferry Building. Looking at the situation on the westerly border of the fire, the strong southwest wind of Wednesday night had brought relief to the situation and no advance of consequence had been made beyond the western limits; but during Thursday morning the rising east wind, which relieved the situation on the east shore and on the southern boundary near the railroad, confronted the defenders on the west with an alarming peril—that of losing the only closely inhabited part of the city remaining, i.e., the so-called western addition, west of Van Ness Avenue. All Thursday afternoon and night a desperate stand was made at this 125 foot street, all forces being concentrated for that purpose. A regularly organized plan for the use of explosives was put into operation and over a space of a mile in length along the east of Van Ness avenue, several blocks in width, practically all large buildings were blown up as far as practicable and extensive back fires were started. Water was obtained by the existing relays of a widening and easterly windward of this sweep had got into the very vulnerable flame dwelling district on the southwesterly slopes of Nob Hill and had swept up and over it. A vigorous though futile stand was made at the fireproof Fairmount Hotel. Acting Chief Dougherty strung from the foot of Mason street a 34-mile length of hose, which was fed by the pumps of a revenue cutter. Most of this hose was afterwards lost by the northerly spread of the fire. Assisting the Fire Department at the Fairmount were Lieut. McMillan of the “Bear” with U. S. sailors and soldiers, but by morning it was seen that the hotel and all the surrounding high class residential sections had been involved and that the west and north sides of Union Square were burning, including the Fireproofs, Spring Valley Water Co., St. Francis, Shreve, Sloane, Bush Street Telephone Exchange, Hotels Alexander and Hamilton, Bullock and Jones Building and four unfinished steel frame buildings. Farther northeast the Hall of Justice, badly wrecked by the earthquake, caught early Thursday morning. This building had brick and stone bearing walls, steel frame and tile arch floors, and was deserted during the fire. The steel cells on the fifth floor fell through to the basement. Fire cleaned out the combustible interior of all but the north side, where rooms remained in habitable condition, and a large part of this building survived structurally. During the morning the wind had lightened and soon after turned its direction and blew from the east; but, meantime, Chinatown had been reached and during the morning was wiped out. Further to the east the early morning fire had swept up through the frame district between Russian and Telegraph Hills, leaving untouched another part which was involved in the return fire which followed when the wind changed.

Fourth Period.—On Friday morning, the third day of the fire, it was a matter of serious doubt whether the advance could be checked after all, when fortunately the east wind ceased and a strong wind sprang up from the west. This finally ended the advance towards the west and southeast; but, during Friday, the westerly wind, which later on veered to blow from the northwest and then finally from the southwest, carried the fire into several previously unburned districts in the northeast part of the city. One stretch of the fire worked down to the northwest slope of Russian Hill towards North Beach, where the northwesterly shift carried it across to Telegraph Hill, destroying the frame Italian district, and renewing the threatened attack on the east shore where were situated a group of factories and warehouses not previously involved. This northwest wind of Friday afternoon was very strong; but it directed the fire mainly to a district on Telegraph Hill which had gone with Friday’s fire; so that a part of the group of factories and warehouses mentioned, being out of the direct sweep of the blaze, were able, by the help of lines from the Bay and by use of private apparatus to finally escape destruction. Among others the case of the Merchants’ Ice and Cold Storage Company’s plant is notable. This plant involved large values. They secured a city engine and, using their own
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water supply, fought the advance of the fire. Friday morning brought another attack upon the Appraisers' Bdg. and the block west of it from the northwest, which was successfully combated as already described, and the blasting operations to the northwest at the foot of Montgomery avenue may have aided the check at this point. Individual work also saved a scattered group of high class dwellings on the precipitous summit of Russian Hill.

Burnt District.—The conflagration had thus lasted three days and, although there were on Saturday morning a few smouldering blazes on the east water front—which occasionally flared up, endangering the unburned structures—a heavy rain on Saturday brought the situation practically under control. Vigorous and effective measures were now taken to prevent new outbreaks in the unburned districts, where chimneys, gas pipes and electric wiring were quite generally in an unsafe condition on account of the earthquake and where the very scant water supply made the situation most precarious. No time was lost in beginning to destroy dangerous walls, and explosives were used to an unusual degree in this work, causing unnecessary additional damage in places, and also quickly terminating many opportunities for distinguishing the true effects of the fire.

Survivals.—It was now possible to map out the boundaries of the conflagration and to ascertain the behavior of the various types of construction. The general results of the fire were the following, viz.: Entirely within the burned area of 2,831 acres there survived, in a partly habitable condition:

Habitable.—First. Three groups, i. e., a hilltop group of detached dwellings on Russian Hill, a group of warehouses at the foot of Telegraph Hill and a mercantile group near the Custom House.

Second. A factory plant, i. e., the Western Electric Company.

Third. Three U. S. Government buildings, i. e., the Mint, the Post Office and the Appraisers Bdg.; also part of the Hall of Justice.

Fourth. Two fireproof office buildings, i. e., the Hayward or Kohl Building, with a three-story building adjoining, and the Atlas Building, with a two-story building adjoining.

Uninhabitable.—There also survived, in uninhabitable condition, but generally with structural integrity, all but four of the other fireproof buildings, viz.: 38; 15 of which were mercantile and the rest of office or dwelling occupancy; also 6 steel frames of unfinished fireproof buildings. There was but one fireproof building of over two stories in height entirely destroyed, viz., the Alumata Apartment House, which was dynamited.

Baltimore Analogies.—The fact which strikes an observer is the similarity of the results to those in the Baltimore conflagration of 1904. That conflagration was the first in which modern methods of protection received a severe test. The water supply was adequate and was not at fault; the Fire Department was up to a good average and worked with reasonable intelligence; there were 27 fireproof office buildings, most of them of the modern type, and so situated as to reinforce each other and act as fire breaks, if such a thing were possible. Yet it was shown that, in the direct sweep of the fire, as determined by the direction of the wind, nothing survived except as follows, viz.:

First. An occasional one or two-story building favorably located as to shelter or wind currents.

Second. An occasional grade floor in a fireproof building.

Third. The empty shells of the fireproof buildings themselves, none of which had front window protection.

Fourth. A window protected partly fireproof U. S. Government building, with a garrison of U. S. employees who remained at their posts, being aided by the engine of a visiting company.

Fifth. Buildings on the side borders of the wind sweep, where the exposure was confined to ignition from brands and where men and apparatus could maintain a working basis and keep open their communications. There was also something like a successful check of the fire in the path of the sweep at Jones's Falls, which was a stream of water of moderate width, a stand having been made at this point by the visiting New York engines.

Expectation.—Thus, from past experiences, there was no reasonable expectation in San Francisco of the survival of any building after the Fire Department was in retreat, except in cases analogous to those just mentioned. In the main this was true, with the exceptions noted later. Within the burned district not only did all frame buildings succumb, but also all brick buildings having wooden floor beams succumbed, whether their construction was good, bad or indifferent of its kind, and with more or less complete structural ruin in nearly every case except that of the Palace Hotel.

Exterior Limits.—See Plan No. 1. At and within fighting range from the water front the Inlet and Center's Tank, on the south, a successful defense was made on account of the ability to get water, the opportunity for safe retreat and for reinforcements and, finally, on account of the assistance of pumps on vessels.

The inland limits of the conflagration were determined by a variety of causes. First, on the south and southwest, by a windward position, and a thinning out to scattered, low-lying, frame construction. Second, on the west, near the line of Van Ness avenue, by a desperate stand made by the Fire Department in co-operation with men from the U. S. Army and Navy with extensive dynamiting and back-firing. The essential causes, however, were, first, a change of wind, and, second, the presence of water all along this line, first, from the Buchanan street mains; second, from the military and naval hose-lines stretched 2,000 feet from the Bay down Van Ness avenue and supplied by the Quartermaster's tug. There were also numerous cases of individual defense by citizens which contributed to the check on the southwestern and southern borders.
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Fireproof Buildings.—The following is a condensed record of the fire of all the fire-proof buildings in San Francisco. For convenience they are classified into:

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td><strong>Type 1</strong> Steel frame, hollow tile floor arches</td>
</tr>
<tr>
<td><strong>2</strong> Reinforced Concrete floor arches</td>
</tr>
<tr>
<td><strong>3</strong> Reinforced Concrete frame and floor arches</td>
</tr>
<tr>
<td><strong>4</strong> Steel Frame Enclosed</td>
</tr>
<tr>
<td><strong>5</strong> Brick bearing walls, fireproof floor arches</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

In all the following accounts of damage, unless otherwise mentioned, are to be included:

- Contents destroyed.
- Finish floors, wood
- Sleepers,
- Trim,
- Back filling, loose cinders.
- Top floor, hanging ceiling structural damage.
- Attic, rafters unprotected.
- No part habitable after the fire.
- Electrical, gas and plumbing system, surface tiling, ornamental iron work and mechanical plant generally wrecked.
- Windows, ordinary glass, destroyed.
- Sash Doors, " " " "
- Transoms, " " " "
- Skylights, " " " "
- Window protection, none.
- Stairs, slate and metal, structural damage moderate.
- Elevators, iron grille, structural damage severe.

The expression “apparent damage” is used in the following account to indicate what is visible to an ordinary observer. It is known that there was injury to steel frames, floor arches, exterior walls, and other structural elements by straining which is not thus apparent. It is quite certain that had there been no fire many of the structures apparently sound would have required extensive repairs.

**TYPE 1.**

**STEEL FRAME, HOLLOW TILE FLOOR ARCHES.**

1. **CHRONICLE BUILDING (New), 8-16 Kearney street.** Building enclosed, trim not yet begun, lumber on premises, communication open with old Chronicle Building. 15 stories, 5,000 sq. ft. area.

| Frame. | Steel. |
| Floor arches. | Hollow tile, flat arch. |
| Columns protection. | " |
| Girders | " |
| Beams | Skewbacks of floor arches. |
| Partitions. | Hollow tile. |
| Exterior fronts. | Pressed brick. |
| " rears. | Brick. |

Structurally sound, except as below.
- " " " "
- " " " "
- " " " "
- " " " "
- " "

Considerable shock damage to pilasters, 10th floor.

Slight.

Lower webs of tile arches damaged on lower floors. Buckled columns on southwest corner upper floors, above roof of old Chronicle building adjoining.


| Frame. | Steel, also outside bearing walls. |
| Floor arches. | Hollow tile, flat arch. |
| Columns protection. | " |
| Girders | " |
| Beams | Skewbacks of floor tile. |
| Partitions. | Hollow tile. |
| Exterior fronts. | Limestone 1, 2; brick and terra cotta. |
| " rears. | Brick. |

Generally sound, structurally, except as below.
- Extensive damage to lower webs.
- " Local damage. |
- " " " "
- " " " "
- " " " "
- " " " "
- " " " "

Moderate damage.

Slight.

Apparently sound.

This is not strictly a steel skeleton building, as the exterior are bearing walls. Still the interior framing is of modern steel type with vertical continuity. Light columns top floor. Some failed from poor protection.


| Frame. | Steel. |
| Floor arches. | Hollow tile, segmental arch, concrete-filled haunches. |
| Ceilings. | Plaster on wire lath. |
| Columns protection. | Hollow tile. |
| Girders | " |

Apparently sound, structurally.
- Local damage. |
- " " " "
- " " " "
- " " " "

12

<table>
<thead>
<tr>
<th>Partitions.</th>
<th>Hollow tile.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior fronts.</td>
<td>Sandstone and brick.</td>
</tr>
<tr>
<td>&quot; rears.</td>
<td>Brick.</td>
</tr>
<tr>
<td>Finish floors.</td>
<td>Cement.</td>
</tr>
</tbody>
</table>

Generally sound. Local damage. " "

Frame. Steel.

Floor arches. Hollow tile, flat arch.

Ceilings. Lower webs of floor arches.

Columns protection. Hollow tile.

Girders. " " "

Beams. Skewbacks of floor arches.

Partitions. Hollow tile.

Exterior fronts. Marble 1, 2; brick and terra cotta above.

" rears. Brick.

" court. "

Apparently sound, except as below. Local wreckage.

Extensive damage on lower floors. " " "

Stone spalled at windows. Brick slight damage.

Extensive damage. See Fig. 71.

Loose back filling has allowed drop to safes—a number of which went through several floors. Several column failures in basement. Pipes back of column covering contributed to damage of latter.


| Offices, 9 stories, 5,000 sq. ft. area. |

Frame. Steel.

Floor arches. Hollow tile.

Ceilings. Lower webs of floor arches.

Columns protection. Hollow tile.

Girders. " " "

Beams. Skewbacks of floor arches.

Partitions. Hollow tile.

Exterior front. Stone and brick.

" " Brick.

Part of upper floors broken through to roof, from failure of frame protection in attic.


| Dwelling, 5 stories, mansard, 10,000 sq. ft. area. |

Frame. None.

Floor arches. Hollow tile.

Exterior fronts. Sandstone facing.

Steel floor beams were carried by exterior and interior brick bearing walls. Efforts were made to blow up this building.


| Drygoods 1st and 2d, offices above, 6 stories, 19,000 sq. ft. area. |

Frame. Steel.

Floor arches. Hollow tile, flat arch.

Columns protection. " " "

Girders. " " "

Beams. Skewbacks floor arches.

Partitions. Hollow tile.

Exterior fronts. Stone mainly.

" rears. Brick.

S. E. corner rear wrecked. Probably column failures from heat.

8. Union Trust Company, 2-14 Montgomery street.

| Offices, 9 stories, 8,400 sq. ft. area. |

Frame. Steel.

Floor arches. Hollow Tile, flat arch.

Columns protection. " " " "

Girders. " " "

Beams. Skewbacks of flat arches.

Partitions. Hollow Tile.

Exterior front. Granite 1, 2; brick above.

Exterior rear. Brick.

Apprently sound. Frequent ceiling damage, especially lower floors.

Local damage. Slight " "

Frequent damage. Granite spalled under lintels.

Apparently sound.
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TYPE 2.

STEEL FRAME, REINFORCED CONCRETE FLOOR ARCHES.


Stove salesrooms and offices, 6 stories, 3,000 sq. ft. area.

Frame. Steel.
Floor arches. R. I. Concrete (Expanded Metal).
Ceilings. Lath suspended.
Columns protection. Hollow one-inch plaster on Expanded Metal.
Girders. Concrete solid.
Beams. Intermediate concrete beams on suspension strap.
Exterior fronts. Stone 1, 2; brick and terra cotta.

“ rears. Brick.
Foundation on piles.

Melted glass found on 2nd floor.


Apartments, 8 stories, 1,500 sq. ft. area.

Frame, Steel.
Floor arches. R. I. concrete (Roehling B) 12-foot spans.

This building was dynamited and entirely destroyed. (See Fig. 38.)


Clothing and other mercantile, 10 stories, 9,350 sq. ft. area.

Frame. Steel.
Floor arches. R. I. concrete.
Ceilings. Open.
Columns protection. Hollow tile.
Girders. Concrete solid.
Beams. " " "
Partitions. Hollow tile.
Exterior fronts. Stone below; brick and terra cotta above.

“ rears. " " "

Two basement columns with hollow covering buckled, tiers above sunk 1 foot, caused by fire. Other basement columns with solid concrete protection no damage. Tiers above failed, columns subsided straight, adjacent floor slabs disturbed, not broken.


Offices, 8 stories, 3,000 sq. ft. area.

Frame. Steel.
Floor arches. R. I. concrete (Exp. metal).
Ceilings. Plaster on Exp. metal.
Columns protection. Hollow " " "
Girders. Concrete solid.
Beams. " " "
Partitions. Hollow Tile.
Exterior fronts. Slight damage.

“ rears. Brick.

Most of this building was left by the fire in a habitable condition.


Several tenants—tailors, men's furnishing, with manufacturing. 8 stories, 4,000 sq. ft. area.

Frame. Steel.
Floor arches. R. I. concrete (Exp. metal).
Ceilings. Open.
Columns protection. Hollow, plaster on Exp. metal.
Girders. Concrete solid.
Beams. " " "
Exterior fronts. Moulded terra cotta.

“ rears. Brick.

Heavy blasting opposite may be responsible for much of exterior damage. A column on third floor has buckled from heat, see Fig. 135.
THE SAN FRANCISCO CONFLAGRATION.


7 stories, 10,700 sq. ft. area.

Frame. Steel. Sound.
Floor arches. R. I. stone concrete (Roebling B-2). "
Spans. 5 ft. to inches."
Ceilings. Open. "
Columns protection. Concrete solid. "
Girders " 20 inch girders. "
Beams " 15 " beams. "
Partitions. Few plaster and cement on wire lath, metal straps. "
Exterior fronts. Sandstone. "
" rears. Brick. "

This building is conspicuous for its slight apparent damage.

15. CASA CALWA BUILDING, 174-6 Townsend street.

Wine storage, 2 story, 10,000 sq. ft. area.

Frame. Steel. Sound except as below.
Floor arches. R. I. Concrete. " " " "
Beams. Intermediate R. I. Concrete. " " " "
Exterior walls. Brick. " " " "

Dynamiting adjoining, blew out wall. Practically all damage limited to this.

16. FERRY BUILDING, foot Market street.


Frame. Steel. Apparently sound.
Floor arches. R. I. Concrete (Exp. Metal). Sound.
Exterior. Sandstone Facing. "

This building was not reached by the fire. Part of stone exterior of tower fell on roof and broke through to second story. Earthquake damaged frame of tower.

17. FAIRMOUNT HOTEL, California and Mason streets.

Nearly completed, including trim; not yet occupied; lumber and material in quantity.

6 stories, 66,000 sq. ft. area.

Frame. Steel. Generally sound, some serious failures in upper floors.
Floor arches. R. I. Concrete (Exp. Metal). Generally sound, some serious failures in upper floors.
Ceilings. Hollow, plaster on wire lath. Superficial damage.
Columns protection. Concrete solid, except as below. Local damage.
Girders " Solid concrete; part hollow finish plaster on exp. metal. " damage.
Beams " Concrete-solid. Apparently sound.
Partitions. Part hollow tile, part metal lath. Extensive damage.
" courts. Brick. "

Column protection omitted in hollow studded interior spaces, and collapses occurred in such places.

18. FOLGER WAREHOUSE, rear of lot, cor. Spear and Folsom streets.

4 stories, 3,000 sq. ft. area.

Brick walls. R. I. conc. floor arches.

The interior of this building was not reached by the fire.


Market Street Bank, offices, 8 stories, 5,500 sq. ft. area.

Frame. Steel. Sound, structurally.
Floor arches. R. I. cinder concrete (Roebling B-1). " "
Spans. 6 to 7 feet. "
Ceilings. First floor open; rest wire lath. "
Columns protection. Hollow, on wire lath, 1st, 3d; hollow tile above. "
Girders " 15-inch solid concrete. "
Beams " Concrete, solid. Local damage.
Partitions. Hollow tile 4th. "
Exterior fronts. Brick. "
" rears. "

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THE SAN FRANCISCO CONFLAGRATION.

20. **HAYWARD (KOHL) BUILDING**, N. E. corner California and Montgomery streets.
   Offices, 11 stories, 9,000 sq. ft. area.

<table>
<thead>
<tr>
<th>Frame.</th>
<th>Steel.</th>
<th>Sound.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor arches</td>
<td>R. I. concrete on exp. met.</td>
<td>&quot;</td>
</tr>
<tr>
<td>Ceilings.</td>
<td>Hollow; plaster on exp. met.</td>
<td>&quot;</td>
</tr>
<tr>
<td>Columns protection.</td>
<td>Concrete, solid.</td>
<td>&quot;</td>
</tr>
<tr>
<td>Girders.</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Beams.</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Partitions.</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Exterior fronts.</td>
<td>Sandstone 1, 2; brick above.</td>
<td>&quot;</td>
</tr>
<tr>
<td>&quot; rears.</td>
<td>Brick.</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

All wooden trim, including window casings, were metal covered (Berger system). Damage to this building confined to first, second, third and fourth floors and roof house. All the remainder fully habitable, and contents uninjured.


Steel frame, R. I. concrete floor arches (expanded metal). Partly wrecked by shock and subsequently damaged by exposure fire, which caused fall of the cupola.

22. **HARRON, RICKARD & McKONE, MILLER, SLOSS & SCOTT**, and others, south side Mission street, between First and Fremont.

Machinery and similar stock, printing and envelope factory, etc.

| Frame. | Steel. | Apparently sound, structurally. |
| Floor arches. | R. I. Concrete. | " |
| Ceilings. | Plaster on exp. met. | " |
| Columns protection. | Concrete solid. | " |
| Girders. | " | " |
| Beams. | " | " |
| Exterior fronts. | Stone. | " |
| " rears. | Brick. | " |

Exterior walls were bearing walls. Mansard was destroyed by earthquake. Western section was wrecked by earthquake and dynamite.

23. **HOTEL ALEXANDER**, 356 Geary street, between Powell and Mason.

Hotel nearly completed. 11 stories, 4,700 sq. ft. area.

| Frame. | Steel. | Apparently sound, structurally. |
| Floor arches. | R. I. concrete. | " |
| Ceilings. | Hollow, plaster on metal lath. | " |
| Columns protection. | Hollow tile. | " |
| Girders. | Concrete solid. | " |
| Beams. | " | " |
| Partitions. | " | " |
| Exterior, front. | Sandstone. | " |

24. **HOTEL HAMILTON**, 125-7 Ellis street.

Hotel, 12 stories, 3,100 sq. ft. area.

| Frame. | Steel. | Apparently sound, structurally. |
| Floor arches. | R. I. concrete (Collins). | " |
| Ceilings. | Hollow, plaster on metal lath. | " |
| Columns protection. | " | " |
| Girders. | Concrete solid. | " |
| Beams. | " | " |
| Partitions. | " | " |
| Exterior. | Brick. | " |


Wall paper warehouse, 1st and basement; 7 stories, 9,000 sq. ft. area.

| Frame. | Steel. | Extensive damage. |
| Floor arches. | R. I. rock concrete ( Roebling B-2). | " |
| Spans. | 51 feet. | " |
| Ceilings. | Hollow, plaster on wire lath. | " |
| Columns protection. | Part plaster metal lath. | " |
| Girders. | Concrete, solid, 18 in. girders. | " |
| Beams. | " | " |
| Partitions. | Plaster on wire lath, iron studs. | " |
| Exterior fronts. | Sandstone. | " |
| " rears. | Brick. | " |
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Column failures occurred in basement from protracted heat of burning wall paper stack against hollow protected columns. The entire rear section was wrecked, interior and exterior. The column tiers went down straight eight or ten feet in places, retaining their protective covering. A large part of exterior walls were distorted or thrown out. The front section experienced slight structural damage.


<table>
<thead>
<tr>
<th>Frame.</th>
<th>Steel.</th>
<th>Apparently sound, structurally.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor arches.</td>
<td>R. I. cinder concrete (Roebling B-1).</td>
<td>&quot; &quot; &quot;</td>
</tr>
<tr>
<td>Spans.</td>
<td>7 feet.</td>
<td>Superficial damage.</td>
</tr>
<tr>
<td>Ceilings.</td>
<td>Hollow, plaster and cement on wire lath.</td>
<td>Apparently sound.</td>
</tr>
<tr>
<td>Columns protection.</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot; &quot;</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td>Girders &quot;</td>
<td>Concrete solid.</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td>Beams &quot;</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot;</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot;</td>
</tr>
<tr>
<td>Partitions.</td>
<td>Plaster and cement on wire lath on iron studs, some 2 inch hollow and some 2 inch solid.</td>
<td>Extensively wrecked.</td>
</tr>
<tr>
<td>Exterior fronts.</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot; &quot; Brick.</td>
<td>Limited damage.</td>
</tr>
<tr>
<td>Rear rooms.</td>
<td>Stone and brick.</td>
<td>Extensive damage, see Fig. 87.</td>
</tr>
<tr>
<td>Courtyard.</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot;</td>
<td>&quot; &quot;</td>
</tr>
</tbody>
</table>

27. MONADNOCK BUILDING, east side Annie, between Market and Stevenson streets.

<table>
<thead>
<tr>
<th>Frame.</th>
<th>Steel.</th>
<th>Apparently sound, except as below.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceilings.</td>
<td>Plaster on wire lath.</td>
<td>Extensive wreckage, locally.</td>
</tr>
<tr>
<td>Columns protection.</td>
<td>Hollow, plaster on exp. metal.</td>
<td>Generally sound, except as below.</td>
</tr>
<tr>
<td>Girders &quot;</td>
<td>Concrete solid.</td>
<td>Apparently sound.</td>
</tr>
<tr>
<td>Beams &quot;</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot;</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot;</td>
</tr>
<tr>
<td>Partitions.</td>
<td>Plaster on wire lath.</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot;</td>
</tr>
<tr>
<td>Exterior fronts.</td>
<td>Sandstone 1st and 2d; brick above.</td>
<td>Considerable apparent damage.</td>
</tr>
<tr>
<td>Courtyard.</td>
<td>Brick.</td>
<td>Slight</td>
</tr>
</tbody>
</table>

The original plan of this building was for wooden beams, floors of mill type, on steel girders. Altered to reinforced concrete beams carried by steel girders with R. I. concrete floor arches. The building was being extended west and south, and part of those sides was open. Some damage was done by dynamite in adjoining building. A column has failed in basement, and let down surrounding panels above. See Fig. 133.


<table>
<thead>
<tr>
<th>Frame.</th>
<th>Steel.</th>
<th>Apparently sound, structurally.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor arches.</td>
<td>R. I. stone concrete (Roebling B-3).</td>
<td>&quot; &quot; &quot;</td>
</tr>
<tr>
<td>Spans.</td>
<td>7 feet.</td>
<td>Generally sound.</td>
</tr>
<tr>
<td>Ceilings.</td>
<td>Hollow, plaster on wire lath except basement.</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td>Columns protection.</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot; &quot;</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot; &quot;</td>
</tr>
<tr>
<td>Girders &quot;</td>
<td>Solid concrete.</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td>Beams &quot;</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot;</td>
<td>&quot; &quot; &quot;</td>
</tr>
<tr>
<td>Partitions.</td>
<td>Hollow and solid on wire lath, iron studs.</td>
<td>Considerable damage.</td>
</tr>
<tr>
<td>Rear rooms.</td>
<td>Brick.</td>
<td>Slight damage.</td>
</tr>
</tbody>
</table>

Cement finish floors 1st and 2d.


Not in operation, equipment nearly completed.

<table>
<thead>
<tr>
<th>Frame.</th>
<th>Steel.</th>
<th>Apparently sound, exception below.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor arches.</td>
<td>R. I. stone concrete (Roebling B-1).</td>
<td>Sound.</td>
</tr>
<tr>
<td>Spans.</td>
<td>7 to 8 feet.</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td>Ceilings.</td>
<td>Open in basement, plaster on wire lath above.</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td>Columns protection.</td>
<td>Concrete solid.</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td>Girders &quot;</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot;</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot;</td>
</tr>
<tr>
<td>Beams &quot;</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot;</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot;</td>
</tr>
<tr>
<td>Partitions.</td>
<td>Cement and plaster on wire lath on metal studs.</td>
<td>Moderate damage.</td>
</tr>
<tr>
<td>Rear rooms.</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot;</td>
<td>&quot; &quot;</td>
</tr>
</tbody>
</table>

Floor arch broken through, seventh floor. Intermediate roof beams of R. I. concrete, one has failed, leaving hole in roof. Hanging ceiling on the eighth under roof, plaster on wire lath, all down. Window protection, east side and rear, wire glass in metal covered swinging sash,
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hinges screwed to metal covered wood jambs. Inside sliding tin-covered wood shutters, slide back of wall furring, consisting of plaster on cement on wire lath, iron furring frame. Front windows plate glass, metal covered sash, outside rolling steel shutters. The tin-covered shutters as a general rule have bulged away from wall on account of interior fire. Wire glass intact, except at two points. Rolling steel shutters uninjured, glass behind them destroyed and in places melted.

30. PACIFIC STATES Tel. & Tel. Co., 40 West Mission street. Erected 1905.  
South Mission Exchange, 3 story, 7,200 sq. ft. area.  
Frame. Steel.  
Floor Arches. R. L. gravel and cinder concrete (Roebling B-I).  
Spans. 8 feet 2 inches.  
Columns protection. Concrete solid.  
Girders. "  
Beams " 15" beams.  
Ceilings. Open basement, r:st wire lath.  
Partitions. Hollow, wire lath, metal studs.  
Exterior fronts. Brick.  
" rears. "  
Finish floor. Cement.  
West wall upper part, thrown out by earthquake, let in the fire, which burnt out third floor. First and second floors habitable and contents preserved. Building was deserted during the fire.

31. PACIFIC STATES Tel. & Tel. Co., west side Hyde, between Bush and Sutter streets.  
Telephone Exchange ("East" Station) 3 story, 5,750 sq. ft. area, erected 1905.  
Frame. Steel.  
Floor arches. R. L. concrete (Roebling).  
Exterior walls. Brick.  
This building was in a frame dwelling district. Front spandrel beam sagged.

32. POSTOFFICE, Mission, bet. Sixth and Seventh streets.  
General Post Office, 3 stories, 68,000 sq. ft. area.  
Frame. Steel.  
Floor arches. R. L. Concrete, cinder, exp. metal.  
Ceilings. Hollow, plaster on exp. metal.  
Column protection. 4" concrete and brick solid.  
This building was not injured by the fire except slightly to the exterior, the court room and two rooms on third floor north corner, burnt out.

33. RIALTO BUILDING, S. W. corner Mission and New Montgomery streets.  
Offices, 8 stories, 16,000 sq. ft. area.  
Frame. Steel.  
Floor arches. R. L. concrete (exp. metal).  
Ceilings. Hollow, plaster on wire lath.  
Column protection. "  
Girders " Concrete solid.  
Beams "  
Partitions. Hollow tile.  
Exterior fronts. Pressed brick.  
" rears. Brick.  
Column failures in basement, two in northwest corner, one in northeast corner. Cause unknown. Column tiers above subsided vertically with extensive wreckage of adjacent floors. See Fig. 99. This building was in the region of severe earthquake effect and was also a victim of attempted dynamiting operations.

34. SHREEVE BUILDING, N. W. corner Post and Grant streets. Erected 1905.  
Silverware and jewelry 1st and 2nd, offices above. 12 stories, 9,000 sq. ft. area.  
Frame. Steel.  
Floor arches. R. L. stone concrete (Roebling B-I).  
Spans. 15 feet.  
Ceilings. Hollow, plaster on wire lath.  
Columns protection. Concrete solid, 1st and 2nd, tile above.  
Girders " Concrete solid, 15" and 18" girders.  
Beams " Concrete solid, 12" beams.  
Partitions. Hollow tile, 4 inches.  
Exterior fronts. Limestone.  
" rears. Brick.  
Part of finish floors, cement or tile.  

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THE SAN FRANCISCO CONFLAGRATION.

35. Spreckels (Call) Building, S. W. corner Market and Third streets.

Offices and newspaper publishing, 16 stories with 5 story dome, 310 ft. high, with annex on west, 5 stories.
5,625 sq. ft. area, 75 x 75.

Frame. Steel. Apparently sound, structurally.
Floor arches. R. I. concrete. " " "
Ceiling. Plaster on wire lath. Local damage.
Columns protection. Hollow tile. " " "
Girders " Concrete, solid. " " "
Beams " " " "
Partitions. Hollow tile. " " "

Foundations on platform of steel beams and concrete 4½ feet thick extending beyond house-line. Special plan of bracing very useful in preventing damage from shock.

36. St. Francis, west side Union Square.

Hotel, 12 stories, 22,000 sq. ft. area.

Frame. Steel. Generally sound, structurally.
Floor arches. R. I. cinder concrete (Roebling). " " "
Spans. 6 and 7 feet. " " "
Ceilings. Hollow, plaster on wire lath. " " "
Columns protection. Concrete, solid 1½, tile above. " " "
Girders—depth. 18 to 20 inches. " " "
Girders protection. Part solid concrete; part ornamental plaster on wire lath. " " "
Beams. Concrete solid, 10' to 12' beams. Apparently sound.
Partitions. Hollow tile, 4 inches. Extensive damage locally.
Exterior front. Stone below, brick above. Apparently sound.
" rears. Brick. Extensive damage, see Fig. 103.
" court. " "

Some rooms were left partly habitable. Some column failures where protection was poor.


Express Offices, 5 stories, 19,000 sq. ft. area.

Frame. Steel. Generally sound, structurally.
Floor arches. R. I. concrete (Ransome). " " "
Ceilings. Hollow, wire lath. " " "
Columns protection. Concrete. " " "
Girders " " " "
Beams " " " "
Partitions. Tile. Local damage.
Exterior fronts. Granite 1-2; brick above. Granite much spalled.
" rears. None. " "

Earthquake X cracks in pilasters.

TYPE 3.

Reinforced Concrete Frame, R. I. Concrete Floor Archies.

38. Academy of Sciences, 819 Market street, rear of lot.

6 stories, 7,500 sq. ft. area. Erected about 1886.

Girders and beams. R. I. concrete (Ransome). " " "
Floor arches. " " "

Extensive interior wreckage, partly by dynamite. Communication by 2 story portion with 6 story front building of ordinary construction.


To be storage. In course of construction, 2 of 6 stories completed, 6,000 sq. ft. area; building material on premises.

Columns. R. I. concrete (Kahn system). Superficial " " "
Girders and beams. " " " "
Floor arches. " " " "

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TYPE 4.

STEEL FRAME, UNFINISHED.

40. BUTLER BUILDING.
To be occupied by Newman & Levison, dry goods; building unfinished; steel frame completed; 9 stories, 19,000 sq. ft. area; floor arches in to 2nd story; exterior walls completed to 4th story.

Frame. Steel. Apparently sound, exception below.
Floor arches. R. I. concrete (Roebling). 

Part of exterior walls thrown out by shock and fire. Slight damage to frame locally.
41. UNION LEAGUE BUILDING, Geary street, north side, between Stockton and Grant streets.
16 stories, 4,000 sq. ft. area.

Frame, steel; completed; apparently sound, except a few beams second floor front slightly sagged. No floors nor side walls yet begun. There was a small quantity of lumber on the first floor.
42. MARSTON BUILDING, corner Kearney street and Hardie Place.
3 stories, 1,200 sq. ft. area.

Frame. Steel, complete. Apparently sound.
Floor arches and intermediate beams. R. I. concrete.
Columns protection. Concrete solid.
Girders. “ “ “
Beams. “ “ “
Exterior. Brick complete to 7th story. Extensive damage from shock.

There was a quantity of lumber and material on the premises. The upper parts of the unfinished side walls were thrown out and some damage was done to corners of brick-work from the shock of the earthquake or neighboring blasts.
43. NEW BUILDING, north side Mission, between First and Second streets.

Frame. Steel up two stories. Sound, except a few beams sagged in front.

No walls nor floor arches yet erected. A small quantity of scaffolding was on the premises.
44. RUEF BUILDING, corner Pacific street and Montgomery avenue.
To be apartments, 7 stories, 2,000 sq. ft. area.

Frame. Steel, very light. Apparently sound.
Frame completed. Floor arches part in. Side walls not in. Some lumber and material were on the premises.
45. ST. FRANCIS HOTEL ADDITION, Union Square. Adjoins hotel on the north.
To be 12 stories. Erected 1896.

Frame. Steel, up 10 stories. Apparently sound.

No frame protection. Side walls and floor arches not yet in. A quantity of lumber was on the premises. Open communications with the hotel.

TYPE 5.

BRICK BEARING WALLS. FIREPROOF FLOOR ARCHES.

46. APPRAISERS’ WAREHOUSE, Sansome street, between Washington and Jackson streets.
U. S. Custom House, etc., 3 stories, 25,000 sq. ft. area.

Brick walls, slate roof, brick arched floors on iron beams 3 to 5 foot spans. Cast iron columns unprotected except where in partitions. Fire did not get into the interior of this building, consequently there was no test of its construction.
47. HOBART BUILDING, 532-8 Market street.
Postal Telegraph Company, offices and operating department, 6 stories, 8,000 sq. ft. area.

Floor arches. Concrete not reinforced. Generally sound, except 1st floor partly out.
Spans. 4 feet. Generally sound, except 1st floor partly out.
Columns protection. Cast iron, covered; no columns above first. Some sagged in basement.
Girders “ No girders above first; on first unprotected. 
Beams “ None on lower flanges. 
Ceilings. Wire lath and plaster under beams. Generally sound. 
Exterior front. Brick, with granite columns first floor. Brick, local damage; granite columns, some destroyed by heat.

The roof of this building was wrecked.
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48. CHRONICLE BUILDING (old), 642-50 Market street. Erected 1890.
   Newspaper printing and publishing, 10 stories, 7,000 sq. ft. area.

<table>
<thead>
<tr>
<th>Bearing walls.</th>
<th>Brick.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor arches.</td>
<td>Hollow tile.</td>
</tr>
<tr>
<td>Columns protection.</td>
<td>Cast iron, tile covered.</td>
</tr>
<tr>
<td>Girders.</td>
<td>Iron not covered.</td>
</tr>
<tr>
<td>Beams.</td>
<td>&quot; flanges exposed.</td>
</tr>
<tr>
<td>Partitions.</td>
<td>Hollow tile.</td>
</tr>
<tr>
<td>Exterior fronts. rear.</td>
<td>Brick.</td>
</tr>
</tbody>
</table>

Eastern section of this building was apparently structurally sound. Western section collapsed from the roof down. This is known to have occurred after 12 o'clock Wednesday. There was a frame clock tower on the roof. There was probably a collapse of columns from heat.

49. SLOANE BUILDING, 114-24 Post street.
Carpets and furniture, 7 stories, 14,000 sq. ft. area.

<table>
<thead>
<tr>
<th>Bearing walls.</th>
<th>Brick.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girders and beams.</td>
<td>Steel.</td>
</tr>
<tr>
<td>Floor arches.</td>
<td>R. I. concrete.</td>
</tr>
<tr>
<td>Ceilings.</td>
<td>Open.</td>
</tr>
<tr>
<td>Columns.</td>
<td>Cast iron, round.</td>
</tr>
<tr>
<td>Column protection.</td>
<td>Hollow, plaster on wire lath.</td>
</tr>
<tr>
<td>Girders.</td>
<td>Concrete solid.</td>
</tr>
<tr>
<td>Beams.</td>
<td>&quot; &quot; &quot; &quot;</td>
</tr>
</tbody>
</table>

Apparently sound, exception below.

This building had several column failures in the basement, apparently from fire. The column tiers above subsided vertically about one foot. The adjacent floor bays were distorted but not broken, and subsequently were knocked out.

50. HIBERNIA BANK, N. W. corner McAllister and Jones streets.
2 story, 17,000 sq. ft. area.

Stone exterior front with heavy architectural features. Brick rear. Interior framing steel, with floor arches of both brick and concrete. Composite roof, iron and wood. Structural injury was confined largely to the roof, and there was heavy spalling of exterior stone under lintels of windows, on east side.

51. MERCANTILE TRUST COMPANY, 430 California street.
Bank, 3 stories, 5,500 sq. ft. area.

Stone front, brick side and rear walls. Interior frame steel. Floor arches R. I. concrete. Roof arched, steel frame and glass. Structural injury was largely confined to roof.

52. SECURITY SAVINGS BANK, 314 Montgomery street.
Bank, 2 story, 2,400 sq. ft. area.


53. CITY HALL, Larkin and McAllister streets.

Exterior stone and brick, with columns of cast iron filled with concrete, all grouped around a skeleton steel dome.
Floors steel beams, corrugated iron floor arches. This building was wrecked by the shock and subsequently gutted by exposure fire.

54. U. S. MINT.
3 stories, 20,000 sq. ft. area.

Granite faced brick walls, flat roof, brick arch floors on iron beams, 3 to 5 foot spans. Cast iron columns, unprotected except by partitions.
Fire did not get a footing in the interior of this building, therefore there was no test of its construction.

GLOBE MILLS, W. H.

This was a building with concrete exterior walls, and concrete floor arches on unprotected steel girders and iron columns. The building was structurally wrecked. Not included in fireproof class on account of non-protection of structural metal.

NATOMA ST., N. W. corner of 1st.

This was a building with brick bearing walls on protected cast iron columns, steel girders and R. I. concrete floors. Front bays of all floors also all of upper floors wrecked. Not included in fireproof class on account of non-protection of structural metal.
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Conclusions.—The most notable facts of this conflagration are not so much the confirmation afforded to generally accepted views, as the light thrown on debated matters connected with fire protection.

Confirmation of Old Data.—Among previously accepted views which were confirmed are the following:

1. The paralyzing effect of a number of simultaneous fires.

2. The weakening of the fire-fighting force as it thins out over a wide front.

3. The impossibility, with existing methods, of front resistance to the sweep when the wind velocity exceeds a certain critical figure.

4. The special vulnerability of leeward upslopes.

5. The futility of explosives, except where there is close cooperation with hose streams.

6. The structural ruin in conflagrations of all wooden joist brick buildings where the stability of the walls in any way depends upon the bracing by the beams.

7. The structural ruin to be anticipated in conflagrations in all wooden joist brick buildings where the wall bracing depends upon unprotected iron and steel girders or columns.

8. The limited utility in a conflagration of rear and side shutting where front windows remain unprotected.

9. The ignitibility in conflagrations of ordinary roofs, consisting as they do of wooden boards with a thin veneer of tin or other roofing material.

10. The slight value as conflagration breaks of fireproof buildings when abandoned.

11. The possibility in conflagrations of holding buildings even with unprotected openings, provided there are some men, even a little water, and the openings are few.

12. The little reliance to be placed on street widths as positive conflagration fire breaks.

13. The structural survival, even without window protection and when abandoned, of steel frame buildings with fireproof floor arches, provided the steel frame is properly ensconced with fireproof material, the structural damage being in close proportion to the excellence of the frame protection.

14. The more or less complete destruction in such buildings of all non-structural interior; heavy spalling of all kinds of facing stone, with little distinction as to kind, the injury to ornamental moldings and moldings; extensive damage to hollow tile in floor arches and partitions as ordinarily constructed; a marked increase of injury where wood finish floors are used over the floor arches; the danger from falling safes where there is loose back filling; the failure of unprotected cast iron mullions and spandrels in courts, and the weakness of roofs carried on unprotected steel rafters with suspended ceilings.

New Data.—The most notable facts in respect to the light thrown upon debated matters are as follows:

1st. The case of the Bush Street Telephone Exchange, which had a high type of window protection, but was full of combustible contents, was shut up tight and abandoned to the maximum conflagration exposure. The structure and the window protection resisted successfully the general sweep of the conflagration; but some unascertained leak admitted the spark which originated an interior fire, causing as complete interior destruction as if there had been no window protection at all.

2d. The partial success of the South Mission Telephone Exchange, a window protected, fireproof building, in a frame district. This building was abandoned and yet survived with two floors in habitable condition and a large part of the switchboard equipment intact.

3d. The saving of the Kofl building, a steel frame office building with reinforced concrete floors, and with metal covered trim and cement floors throughout. This was noteworthy as the first conflagration experience of this type of interior and window trim. The glass was ordinary plate glass, and all partitions had ordinary glass transoms. Caution must be exercised in drawing broad conclusions from this case. The fact that the majority of the plate glass windows are not even cracked shows that the upper floors did not receive any severe attack. The building was not deserted during the fire. Furthermore, the three lower floors are extensively burned out, the wood having ignited under its metal sheathing, showing that when the glass of windows breaks and fire takes hold of the contents of the room the heat soon penetrates the thin metal sheathing of the trim. Still there is a definite, though small, advantage in this detail of protection, which advantage may be thus accounted for. The characteristic feature of a conflagration is the direct attack from flame and heated gases. Nevertheless, there are places, especially in a region of fireproof buildings, where the prevalent cause of ignition is not this general drift so much as it is sparks and brands which lodge on window sills and ignite the sash frames. Then again, especially in a region of fireproof buildings, there will be many places where the temperatures are just on the margin short of the point where plate glass will break, but above the point where exposed and painted wood will ignite. In these cases the fact that the window trim is metal covered may turn the scale. Furthermore, the attempt in a conflagration to save a fireproof building with unprotected windows by people making a fight from inside will usually fail, even if they have water, because of the great disproportion between the probable number of people and the number of windows to be guarded. It is probable that not more than three or four men are likely to make an effort to remain in a fireproof office building exposed to a conflagration, and to use the private water and hose in an effort to save the building;
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whereas a ten-story office building with a 50 foot front will have over 100 windows on its front and rear. The two prominent cases of successful defense of unprotected windows were the Mint and the Custom House, the first with 150 men at times and 30 windows on a side. Furthermore, both were only 3-story buildings, below the drift of flame and heated gases, and in addition were mainly fireproof construction. The building whose window trim is slowly combustible has, therefore, an appreciable advantage, even with ordinary plate glass and no shutters.

Going higher in the scale of window protection we have the case of the Western Electric Company, with its wire glass windows. These still cannot be regarded as standard inasmuch as the defect well known to fire protection engineers, namely, diathermancy, developed the anticipated effects, namely, ignition through the glass. It is important not to be misled as to the lessons of this fire. The breakdown, at the start, of their fine private equipment for fire defense left the occupants with but slight advantage over other buildings in the sweep of the conflagration. Their mill construction, automatic sprinklers, yard reservoir and outside hydrants did not save them. It was the retardant, though not positively resistant effect of the wire glass and metal frame window protection which gave the small force of two or three men a chance to take care of 50 or 60 windows and extinguish ignition fires in detail. The independent water supply also left a small residuum for buckets, which was the other essential.

Had this plant not made the very natural and perhaps excusable deviation from strict factory standard in having an electric instead of a steam underwriters' pump, it might have afforded the missing data as to the ability of such an equipment to resist a conflagration.

Fire Shutters.—As before referred to there were no chances to observe the legitimate action of fire on shutters because in nearly every case the fire got in elsewhere, and attacked the shutters from the inside. Several walls were standing, however, with tin covered shutters still hanging at their window openings and apparently sound. Old fashioned inside folding iron shutters deserve credit in several cases. The two lower floors of the Mint were protected with then. and, though the glass in the sash was destroyed the shutters appeared to have been uninjured. In the old non-fireproof warehouse block, which survived to the west of the Custom House, the buildings, 2 or 3 stories high, were nearly all furnished with inside folding iron shutters to all windows front as well as rear. These shutters appear uninjured, although much glass is broken. The fact, however, that many glass windows on this block were not broken indicated that the fire conditions at this point must have been rather mild; yet doubtless these shutters were of value. The same argument may be used here as was used in the case of the metal sheathed window trim, viz., that many instances occur in conflagrations where even a quite inferior window protection will turn the scale. In the Bush Street Telephone Exchange the windows on the narrow front on Bush street were of ordinary glass and had outside rolling steel shutters. In places the window glass is melted into a mass on the window sill, while the shutters are apparently uninjured. The destructive fire here, as previously mentioned, was the internal, not the external. Yet it is plain that these shutters stood a heat which reached the melting point of glass, viz., over 2,000 F. The side shuttering of this building was described earlier. The inside, tin-covered wooden shutters are heavily bulged and sprung inward from the effects of the fire inside the building. The outside wire glass with metal covered sash is practically uninjured, except in one case, where the shutter had bulged inward and exposed the wire glass. At this point the wire glass has sagged 6 inches and pulled partly out of the sash frame. In the Mission Street Telephone Exchange wire glass in metal covered frame without shutters saved the two lower floors, although the building was abandoned. This building had the advantage of being in a scattered frame district where the exposure, though intense, was of short duration. The reinforced concrete floor arches and the protected floor openings prevented the fire from working down below the top story. The ignition of the top story may have occurred through a break in the side wall, at a point near the roof caused by the earthquake, or there may have been ignition through the glass of the window. It is a unique experience for an abandoned building to save in habitable condition two floors, in a clean swept district, solely by the excellence of its window protection and its floor construction.

Thus, unfortunately, no conclusive data are directly supplied by this conflagration on the subject of the proper rules for windowed protection. But the results point to the importance of sub-standard as well as standard window protection as an encouragement to men to remain in and make an effort to save the threatened building. The number of city buildings in which, for reasons of economy and convenience, it will be possible to secure sub-standard front window protection will probably be large compared to the number of those in which owners can be induced to install protection of the highest standard. The plan of a double line of defense has great merit. Two or more semi-pervious screens one behind the other may be better than a single nearly impervious screen.

It is important to state that the conclusions to be drawn from the action of shutters in conflagrations must be modified in their application to cases of individual fires, where the effects would be different.
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In the fireproof buildings which were burned out, new data were furnished on the following points:

Reinforced Concrete Floor Arches.—The excellent behavior of this type of floor was noticeable. In the Baltimore fire were several cases of reinforced concrete floor arches; but they were on low, small buildings, and the results, though favorable, did not appear decisive for the reason that quite a number of one-story buildings escaped which had no special construction merits. The behavior of one-story buildings in conflagrations is so capricious, on account of the shelter they sometimes get, that caution must be exercised in drawing conclusions. There was one case in Baltimore of a building with reinforced concrete frame, as well as floors, and it made a good record; but the results were not considered decisive for several special reasons. In the San Francisco conflagration, however, 31 fireproof buildings of good height had reinforced concrete floor arches, though all but two had steel frames. Furthermore, 15 of the buildings had mercantile stocks and most of them were exposed to maximum exterior conditions, although there was, of course, no fire and water test. It was an advantage also that a variety of representative types of reinforced concrete construction were present in San Francisco, the results showing a substantial equality in their ability to stand the test. The type of material in floor arches was cinder concrete in buildings erected previous to 1904; but on account of the scarcity of cinders due to the prevalence of the use of fuel oil, later work used stone concrete. It is doubtful whether the reinforced concrete floor arches which have been through the shock and fire have retained their full strength. In this particular the tile arches may have an advantage.

Column Protection.—This was, a matter of particular interest. In Baltimore the protection was generally inferior and much of it was wrecked; yet the percentage of column failures was very small. In San Francisco buildings the tile protection was practically the same as that in Baltimore and a number of the buildings with reinforced concrete floors had tile column protection; but there were several types of concrete column protection which made an excellent record. Air space coverings of plaster or cement on metal webbing did fairly well, though several authenticated cases of column failure occurred with such covering. The best results, however, were shown by solid concrete column covering without air space, the concrete being reinforced by metal webbing. It is probable that the air space idea will be in less repute in all future efforts to armor structural steel. It has been shown to be largely fallacious in practice. An air-space 4-inch brick shell around a column would be good; but would be inconvenient on account of the space occupied.

In office buildings as a general thing the duration of the high temperatures is probably short, and, before the slowly conducting column covering has transmitted the high temperature to the steel, all the combustible material in the immediate neighborhood will have been consumed and a circulation of cooler air begun. In warehouses and even in special rooms of office buildings, where high temperatures are likely to persist for a longer time, the very best column protection is none too good, even at a sacrifice of space. However, the results in the Bush Street Telephone Exchange may be considered fairly decisive as to solid concrete column protection, as well as to reinforced concrete floors. The temperatures in this building were not only extreme, but were also protracted. The very excellence of the window protection prevented the air from entering the building at the sides, while the break in the roof afforded just sufficient draft to generate intense and long continued heat. The large quantity of combustible insulation and other material provided ample fuel, and the writer found numerous cases of melted glass. Nearly all the light iron frame work of switchboard apparatus was found collapsed into a heap and even a quantity of wire nails was found welded into a mass; yet the column protection appeared to be perfect; and the floor arches were apparently sound. The only breaks, one in the roof and one in the floor below, were at points where cutting away had been done to accommodate some of the switchboard equipment. The bracing effect of the solid concrete encasing the steel column is doubtless an important factor, and it is probable that with such reinforcement the steel might even attain a softening temperature without deflection.

On the other hand, the experience of the Kamm Building should be quoted. Here hollow protected steel columns failed in the basement and wrecked the building. The heat was due to the burning of a stock of wall paper close to the columns and it was probably the time element which was fatal. Non-conduction is impracticable. Delayed conduction is the thing aimed at. It is a mere question of time when a given temperature if maintained will penetrate even solid brick or concrete. Much less time will, of course, be required in the case of such light covering as plaster on wire lath. The fact that so many of the San Francisco column failures occurred in basements indicates that protracted effects are likely to be at their maximum in places where burning material has its combustion retarded by debris. Thus it appears that a column protection adequate on upper floors may be inadequate in basements, so that experience points to the desirability of extra heavy column protection in basements, even at a sacrifice of space.

Figs. 132 to 136 give views of column buckling in other buildings and show comparisons with a case in Baltimore.

It must be mentioned that it was a usual thing
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for careful architects and structural engineers in San Francisco to provide their steel frame buildings with a certain amount of extra bracing on account of uncertainty as to the probable effect of earthquakes or this class of structure.

It is unfortunate that there were no examples in the congested district of buildings of reinforced construction entire, but there was one with vertical supports, girders and beams of reinforced concrete instead of steel.

Column Failures.—One is apt to be impressed by the apparently large number of column failures in steel frame buildings, and it is a fact that a majority of the buildings of this type had some such experience. The gravity of this fact cannot be ignored and points to the necessity of working out a standard for column protection. Yet the percentage figures are not so alarming. An estimate of the percentage of buckled columns to the total steel columns in fireproof buildings gutted by the fire shows it to be about one-half of one per cent.

The character of the collapse is the same as experienced in the Baltimore fire, and is similar to that obtained by the Underwriters’ tests of 1896 and the Berlin tests of 1893.

Fireproof Buildings; General Conclusions.
—The interest attaching to the subject of the behavior of fireproof buildings in conflagrations arises from the fact that their nearly complete structural immunity under such conditions, a matter which must now be accepted as established, has a significance apart from the mere fire salvage. It is no doubt a fine thing for a building to demonstrate its impregnable, and it is doubtless a satisfaction for the public, after a conflagration, to find a considerable number of large buildings which look as if they could be quickly refinished and be ready to go again into service. Yet the actual loss, as demonstrated by the Baltimore experience, will probably generally average over 60% and to Underwriters it may be total.

Salvage in Fireproof Buildings.—The illusory nature of this salvage is due to the fact that the most expensive part of the usual steel frame building is not the steel, whose original cost in Baltimore averaged 13% of the total original cost, nor the floor arches whose original cost averaged 5% of the total, nor even the brick exterior walls, whose original cost averaged there, about 15% of the total; but the principal values, viz., 67%, are in other items—such as ornamental stone, decoration, finish, trim, partitions, glasses, interior light metal work, tiling and marble, plumbing, wiring and fixtures, together with a large item in mechanical plant; all of which items are apt to be total losses. It will also be noticed from these figures that inasmuch as the first cost of the floor arches is only 5% of the total value of the building, it makes only 2% difference on the final loss whether, as in the case of the tile arch, 60% is ruined and needs replacing, or, as in the case of the reinforced concrete arch, there may be damage of not over 10%. So long as the fireproofing protects the integrity of the steel frame there is a gain of the 15% represented in the frame itself, though even that is not likely to be of any advantage to the Underwriter, except for a trifling percentage due to the saving of time in rebuilding.

Problem Narrowed.—There is, however, a significance attaching to the fact that a type of construction may have developed which will take care of itself structurally in a conflagration, in that the problem of securing nearly complete immunity for these buildings is reduced to the one matter of protection of windows and other wall openings, the problem being thus narrowed and defined. The hoped-for character of the fireproof building, as a conflagration break, has been considerably discredited in two great conflagrations; but it has also been shown that the American tall building is, in conflagrations, the innocent victim and not the aggressor.

Popular Idea.—This is contrary to the popular idea, which is that the great peril of American cities is in the tall buildings, forgetting that there are necessarily of fireproof construction, whereas lower buildings seldom are. This country has slight experience of medium or low height fireproof buildings, so prevalent in European cities, because the use of fireproof construction has, on account of expense, here, been confined to tall buildings, where such construction is necessary both on account of structural exigencies and because of municipal ordinances. It is not likely that even San Francisco will be able to resist the demand for permission on the part of owners to reconstruct with wooden beam floors, at least to moderate heights, and certainly no American city in this generation is likely to succeed in enacting a law prohibiting the use of wooden structural material, at least in buildings up to four stories in height. Therefore, for years to come, American cities will consist of tall buildings of fireproof construction, surrounded by non-fireproof buildings, ready under unfavorable combinations of circumstances, to develop conflagrations limited only by superior extinguishing methods and by an increase in precautions relating to the occurrence of fires. If such conflagrations are not to involve the valuable fireproofs, the latter must develop a proper system of window protection.

Mill Construction.—Caution must be exercised in drawing conclusions on the subject of mill construction in this fire. There were two buildings in San Francisco whose floor construction was of the regulation type, viz., the Western Electric Company and the Pacific Hardware Company, both of low height; both sprinkler equipped and both saved by the activity of their occupants. In neither case can it possibly be
made out that the floor construction had any bearing upon the saving of the buildings. In the congested district there were several buildings whose floors were of a special type, quite as good for fire resistive purposes as the strictly mill type, viz., a floor five inches thick made by laying 4 inch studs on edge, spiking them together and covering them with 1 inch finished floor. This is a type occasionally used in France and was first applied in the United States in Detroit, in the early 80s. The buildings of this type were the general offices of the Pacific Telephone and Telegraph Company, on New Montgomery street, which was also equipped with sprinklers, and some other buildings in course of construction. All were total losses. The mill type floor has pronounced merits, especially in combination with other things, such as automatic sprinklers and a vertical and horizontal sectionalizing of buildings, but by itself it should be used with caution as a basis for increasing the permitted height limit of non-fireproof buildings.

**Joisted Construction.**—There is but minor interest in observing the behavior of ordinary joisted brick buildings. Practically all, regardless of good or bad construction, were destroyed when once ignited. In many of the mercantile buildings, as is commonly the case, the wooden floor joists rested partly on the bearing walls and partly on steel girders, supported by cast iron or steel columns. Where these iron or steel members were unprotected by fireproofing they and their containing buildings were, without exception, ruined by the fire, as can be seen from photographs of the ruins. There were a few cases, however, of iron or steel column protection in wooden beam buildings, where the results are of interest. These are illustrated in Figs. 126 and 131, showing the survival of whole tiers of columns where even a moderate fireproofing was present. The fact is of rather academic interest, however, as the unprotected girders resting on the protected columns softened and sagged, though in some cases they still had enough bracing effect to keep the side walls from falling; but in no case, except that shown in Fig. 126, is it likely that the structure can be preserved and restored. It is, however, probable that if the girders, as well as the columns, had been fireproofed, it might have been possible to restore the containing buildings, it stands and thus to effect a material salvage, perhaps as high as 20% in the case of an ordinary, plain mercantile building. The smallness of this salvage figure illustrates again how little direct advantage Underwriters derive in conflagrations from construction improvements of this character.

**Old Type Fireproofs.**—There were only two of the older type of fireproof buildings involved in this fire, viz., those with brick bearing walls, rolled iron beams on cast iron columns, with floor arches of brick or tile not protecting the lower flanges of the beam. These were the Post-
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to the Underwriters, though it may be of some to owners. At any rate, a brick wall which will stand up after the floors have burned out is properly regarded as of no small importance as contributing to a possible check of a conflagration.

Vaults and Safes.—The record of vaults and safes in this fire is a melancholy one. The whole subject is one calling for some sort of regulation. The details are not taken up in this report, as the subject was too extensive to be considered properly.

Automatic Sprinklers.—There was but one building in the congested district with automatic sprinkler protection and, without water, it of course had no test, although, with the severe exposure and no window protection, the result would probably not have been different, even had water been present. It will be debated, however, whether a sprinkler system is likely to remain in operative condition after an earthquake as severe as this one, and in that connection note must be taken of the cases of the Western Electric Company, whose piping and tank remained in operative condition, although the brick tank support barely escaped, and of the Pacific Hardware Company, where the earthquake damage to walls was extensive, and the tank was thrown down; but damage to piping was not apparent. There were several cases of elevated water tanks on trestles in various parts of the earthquake region, and apparently most of these survived without injury.

It is, therefore, a reasonable conclusion that automatic sprinklers may be relied upon in San Francisco to remain operative after a severe earthquake, so far as the piping system is concerned. The problem is one of water supply, and is bound up with that of a trustworthy general water supply.

Conditions for Future Water Supply.—It is important to bear all the facts in mind with reference to the matter of damage to the water system on account of their bearing upon the problem of an earthquake-proof water service for the future protection of San Francisco. If we proceed upon the assumption that the city will not again within this era suffer as violent a shock, then, without any radical departure from familiar and approved methods, an efficient system may be projected and created, doubtless with improvements on the present system, possibly under municipal instead of private control. It may be a separate or non-separate fire service, and may include a salt water supply, either primary or auxiliary. New and more frequent distributing reservoirs and mains may be included in the system and a more reliable conduit service may be established, leading from the distant storage reservoirs to these city distributing reservoirs; but the real issue will continue to be whether any system of underground pipes can be relied upon to survive a shock equal to this one. If not, then the most perfect distributing system and the most reliable, abundant and powerful sources will be useless.

It must be borne in mind that San Francisco's water system had an unusual amount of duplication and reinforcement. There were five original sources, three separate conduits into the city, three separate distributing reservoirs, three separate equalizing reservoirs, and five separate high-service tanks. All these were adapted to reinforce each other.

Even a more perfect system of gates, whereby crippled portions may be cut out, would not meet the requirements for a panic-proof as well as earthquake-proof water service. During the first hour of the fire there were 80,000,000 gallons of water in the three reservoirs within the city limits, being rapidly drawn down, of course, by the breaks, but at any rate the point is clear that a shortage of water was not the difficulty. There is no escaping the conclusion that even if San Francisco had had the most perfect water system that can be devised, under ideal management, and with conduits and reservoirs undamaged, yet the breaks of underground distributing pipes, even at a few places, occurring as they would all at once at the critical time, viz., the outbreak of the fire, would have been followed by results not materially different. Salt water mains would have been equally crippled. Steel pipe would not have survived better than cast iron, breaks involving sheer drops of 3 and 4 feet in the street grade. There is no doubt that the liability to extensive damage may be reduced considerably by observing certain lessons of this event. Omitting, for the present, any consideration of apparently well-founded theories as to the existence of a fault or line of weakness running through the solid formation on a line from Lake Merced to and through San Andreas Lake, which line of weakness should be avoided by future conduits, and confining ourselves merely to considerations which are quite obvious from observations of damage done within the city limits—not only to water pipes, but also to sewer and gas pipes—it is clear that a large part of the liability to damage may be avoided by deep foundations for pipe lines where laid through soft formation. It will also doubtless be possible to make future house connections in a manner less liable to fracture in case of earthquake. Still, in spite of all these possible improvements, there will be a residuum of liability whose seriousness cannot be ignored. The bleeding of water systems by broken house connections is a familiar difficulty during conflagrations; but they usually occur progressively, as one building after another is wrecked by the spread of the fire, and it is conceivable that a highly organized gate manipulation would keep pace, to a certain degree,
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with the wastage of water; but the case is
different where most of the damage occurs in-
stantly. The particular difficulty of broken house
connections can, of course, be met by a separate
fire main system, but the latter would itself still
be liable to break. The conclusion cannot be
avoided that, if San Francisco is to have in the
future a degree of security on the subject of
water supply reasonably approximating that of
other cities, the regular pipe system will have to
be supplemented by a supply of some kind in-
dependent of any underground pipe system.

Interference with Individual Protection.—
Municipal and military authorities should be
careful how they act in conflagrations in the
matter of interference with the individual ef-
forts of citizens to protect their property. In
San Francisco the efforts to prevent looting
and less of life probably were effective in sav-
ing the owners many thousands of dollars, and
may have saved lives. But this very policy was
probably responsible for losses of millions
which might have been avoided had not own-
ers and occupants been driven out of their own
premises by police and military authorities,
and by the danger from explosives.

Prominent Lessons.—Among the more
noteworthy lessons of this fire in the matter of
conflagration-fighting are:
(1) The importance of front as well as rear
and side window protection, fire-resistant if possi-
ble, but at any rate fire-retardant.
(2) The importance of encouraging individual
protection by occupants of buildings.
(3) The importance of fire-resisting roofs,
roof structures and of well protected skylights.
(4) The importance of ample water supply
and pressure.
(5) The importance to the Fire Department of
a large reserve of hose.
(6) The importance of Fire Department appa-
rus of longer range and heavier calibre. Such
apparatus need not be limited by the same con-
ditions of quick response to alarms as ordinary
apparatus.
(7) Restriction upon the use of explosives in
conflagrations.
(8) In hollow tile for fireproof buildings, the
importance of improved sections giving greater
strength to lower webs.
(9) The importance in partitions of a better
bracing of tile, and the importance of fire re-

tardent transoms as well as doors.
(10) The importance of better protection to
the steel frame in roof attics.
(11) The importance of good bricklaying and
mortar with cement instead of lime.
(12) The encouraging possibilities of rein-
forced concrete, and the importance of good en-
geineering in its installation.
(13) The necessity of adopting standards for
column protection.

Dwelling Sections.—It has been considered
a reasonable assumption that a conflagration de-
stroying the business part of a city would still
probably be checked in the brick dwelling quarter.
The experience of San Francisco, whose dwelling
district was almost entirely frame, cannot be
considered a ground for changing this view.