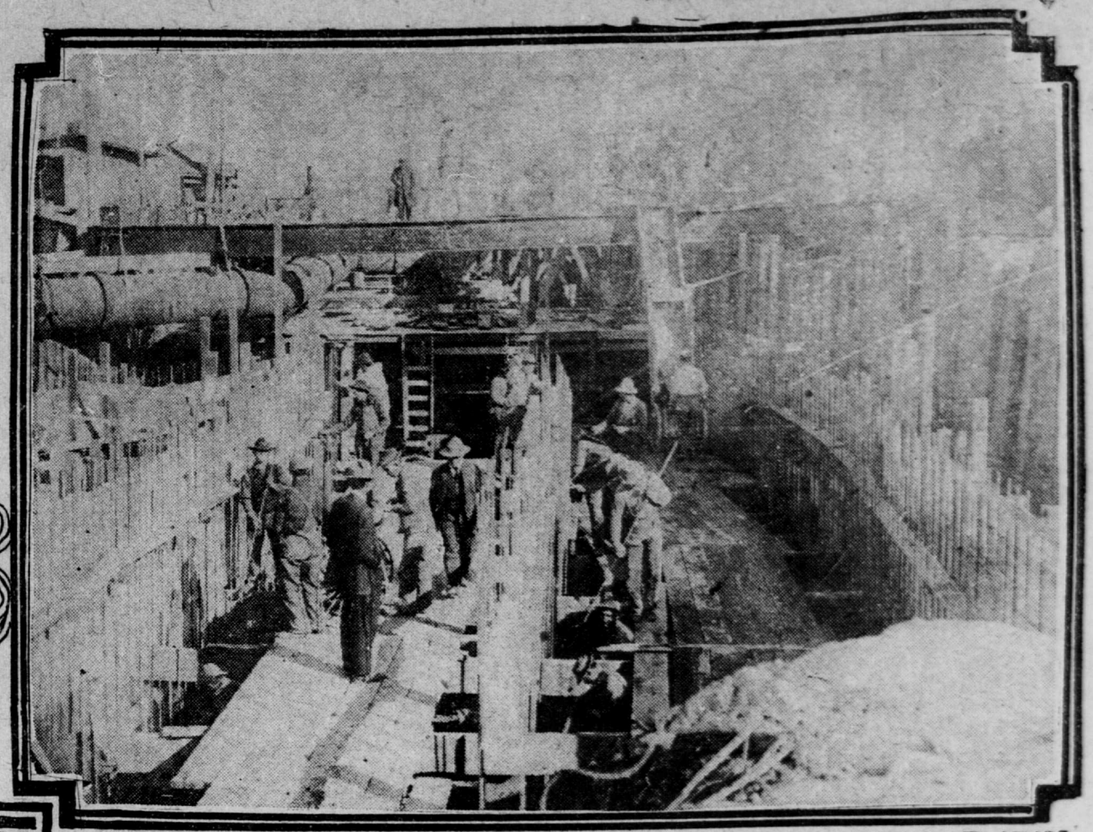
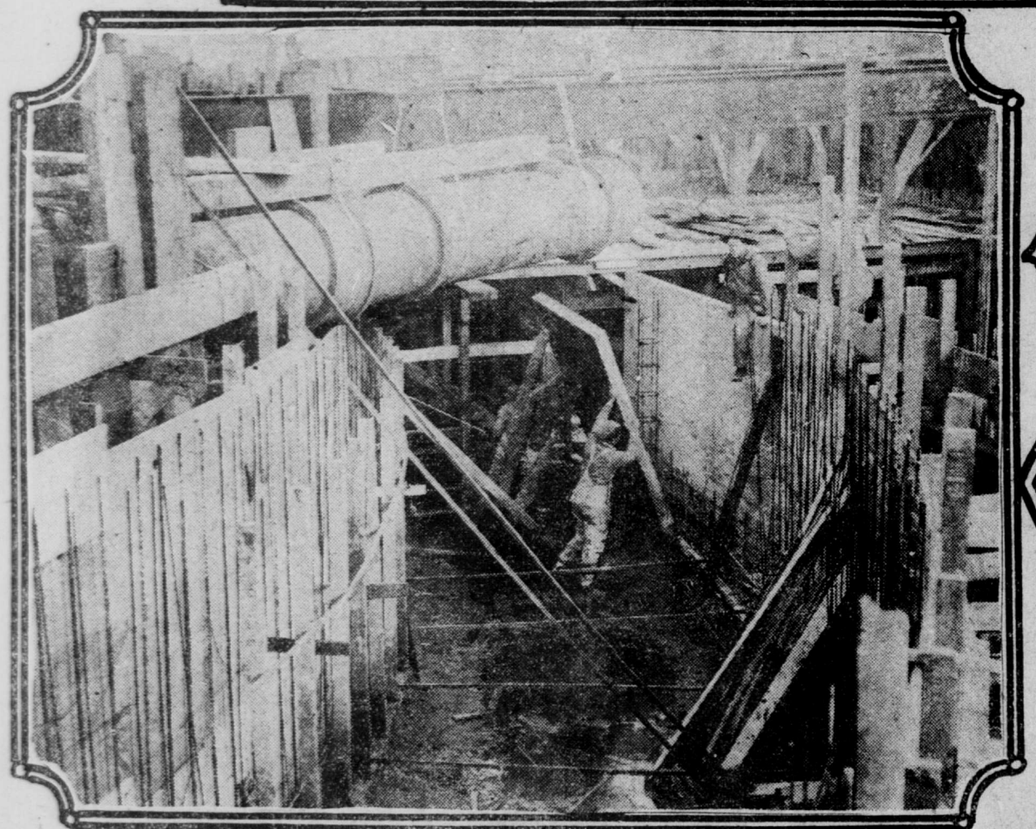
San Francisco's Great Sewers

How Mammoth Mains Are Being Constructed to Give the City the Greatest System in America



END OF SECTION B AT 10TH ST.- SHOWING CONSTRUCTION OF THE TWO MAIN INVERTS. BRANCH INVERT AND DISTRIBUTION CHAMBER

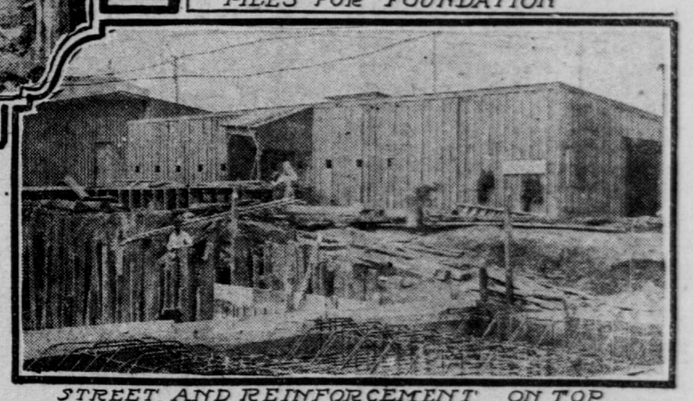


SETTING UP A "FORM" IN BRANCH INVERT AT 10TH ST. END OF SECTION B.

THE MIXER AT WORK MAKING CONCRETE FOR WALLS

PILE DRIVER AT WORK DRIVING PILES FOR FOUNDATION

THE EXCAVATION ALONG THE LINE OF THE NEW SEWER



STREET AND REINFORCEMENT ON TOP OF SEWER

By M. Garnett

"Cloacina, goddess of the tide,
Whose sable streams beneath the city glide."

So sang the poet Gay of the guardian deity who in the old Roman mythology presided over the city's sewers. At the first blush it would seem that the bard flung this little flower of poesy at the muse's feet either in a self-defensive spirit or else in a playful attempt to justify his patronymic. But the fancy was not without its basis in fact. Viewed in the light of the chief object to be attained even a city's sewerage system may assume a somewhat poetic aspect. The transforming of squalid, noisome sections of the town into attractive neighborhoods, thereby bringing health and possibly wealth and happiness to the general resident and property owner, as well as to the real estate dealer, is an aim not exclusively prosaic.

From this viewpoint the importance of the comprehensive system of sewerage projected for the new San Francisco can hardly be exaggerated. The execution of the design, now well under way, will conform, with slight modifications, to the plans of former City Engineer C. E. Grunsky and his associate, Marsden Manson. When finished it will give San Francisco a sewerage unsurpassed if not unequaled by any other American metropolis. It will even go far to justify, in one essential at least, the application to our own fair city of that somewhat Delphic distinction, the "Paris of America." Yet comparatively few of the tax payers who are footing the bills for this huge enterprise have the faintest conception either of the nature or of the progress thereof.

Of all the civic improvements to be completed under the bond issue of $18,200,000, voted on May 11, 1908, none is more essential, nor more sorely needed for the city's welfare, than the contemplated sewer construction. Before the scope of the latter, the $4,000,000 appropriated for the purpose seemed to fade into insignificance. But with the competent supervision now in force the sum will probably suffice. And a contrast of the new order of things with the old should edify the general reader.

In the matter of sewerage and sewage disposal San Francisco has lagged further behind European and other large American cities than is generally realized. Though sewerage systems, as now understood, date only from about the middle of the nineteenth century, even in London going back no further than 1859, in Paris to the completion of her system in 1893 and in Boston to the municipal control in 1823, all important cities in Europe and in the United States have for years managed their sewage problems with something like adequacy. In those municipalities both the combined and separate sanitary systems are in general use. Purification works, filter beds, or chemical treatment, as adjuncts, to dilute the sewage, have been adopted wherever this could not be properly delivered into river, bay or ocean. But San Francisco, with all her unrivaled advantages of drainage areas, sloping lands, abundant points of outfall into the deep, swift tides of the bay and ocean, has gone on her merry way apparently indifferent to the importance of thoroughly flushing the general body civic—to say nothing of the body politic. And this is all the more remarkable in view of the influence sewerage improvements have been found to have on the general death rate of cities. In some instances a reduction of 25 per cent in the rate of death from pulmonary diseases alone has followed the introduction of modern sanitary systems of sewerage.

The defects of the old system may be said to have been felt, rather than seen. A stroll along the water front on a warm day, or the necessity of waiting on a street corner near one of those numerous storm water inlets, lurking under the curb, has often convinced the San Franciscan that something was radically wrong with his sewerage. Had he known the truth, however, he probably would have been roused into defensive action long before May 11, 1908. The perfume embalming the atmosphere he vaguely attributed either to the low tide or to the lack of a sewer flushing rain. But he seldom even suspected that underlying the most populous parts of the city was a network of old brick, pipe and wooden sewers, often on streets without gradients, or with downgrades in both directions from the storm water inlets at the street corners. As no water could flow into these intakes they were, of course, useless, and, in the dry season, vilely malodorous. In fact, it was found in 1893 that in the district bounded by Taylor street on the east, Broderick on the west, Washington on the north and Hayes on the south there were 1,080 storm water inlets, of which 149 were absolutely worthless. And many more were rendered unnecessary by the fact that they received water from a negligible area of street surface. The cost of these superfluous inlets, or catch basins, to the property owners was about $90 per superfluous catch basin.

In the less densely settled districts such as the Islais creek, the Precita creek, the Visitacion valley, Washerwoman's bay, Lobos creek, Presidio and ocean beach watersheds, the sewer deficiencies are not so serious, and are more easily remedied. There the discharges are either through marsh lands into natural streams, or else into tide water, where extensions are easily feasible. Where, however, there is a long bay frontage, as in the North beach region, the sewers now in use empty into the bay wherever they happen to hit the water line, and offer difficulties not readily surmounted.

Old Construction Faulty

As a type of faulty construction, and lack of comprehensive plan, the sewerage of the Yerba Buena watershed is especially interesting. This is the low, flat part of the city north of Market street, whose water frontage was once Montgomery street, and whose watershed includes the slopes of the hills to the north and west. It embraces the most important business section of the city. About 120 acres of it consist of filled in land. Under almost every street and alley in this historical district is the old 3x5 foot sewer, and at every street crossing the typical sewer intersection. Streets running north and south with level surfaces are not rare. In 1890 a common outfall at Washington street was made for these sewers, and for the Market street sewer, as far north as Jackson street. The sewage from the west, including the intersections by the lower Market street main of all the sewer contributions from Geary street to Sacramento street, was also intercepted and discharged at the foot of Washington street, at the low water line under the wharf. The sewers on Brannan, Folsom, Howard and Mission streets likewise have their outlets under the wharves or piers of the water front. As a means of savorizing these frequented parts of the city, it is doubtful if this method of sewage disposal arouses the enthusiasm of either the regular or volunteer denizens of the water front.

It is in the Mission bay watershed, the drainage basin tributary to Mission bay, that the problem of effective sewage disposed seems to be most difficult. This area includes the heart of the city, the entire Mission and Western addition, and almost all of its sewage reaches the open waterway in Channel street. Frequently the lack of rain and of water circulation in the old Mission creek causes a noisome nuisance that would almost resurrect the dead. It will not cease to offend until some other outfall, contemplated on the new plans, is found for the sewage of this district. Furthermore, the inability of the principal sewers of this watershed, namely, the Channel street and Brannan street mains, to care for the contributions therefrom is aggravated by the nonconformity of the Brannan street sewer grades with those of the sewers the Brannan street conduit intersects. The latter are often from one to three feet higher than the bottom of the former. In the tunnel under the south slope of Rincon hill there is an offset of about 12 feet, and the bottom grade for a considerable distance slopes the wrong way. That under the conditions here roughly sketched San Francisco has won the distinction of the most healthful metropolis in America seems to put a heavier debt of gratitude than is generally acknowledged upon her trade winds, generous sunshine and other climatic blessings.

Despite, then, the many favorable features in the problem, the board of public works and the city engineers have grappled with a task more formidable than can be easily realized. This new system will drain the entire watershed east of the main ridge that divides the city into two great slopes and has its northern limit near Fort point. The western, or ocean slope, in addition to the project adopted in 1899 for the Richmond district, and yet to be completed, will have branches in the west Richmond, upper Sunset, lower Sunset and Ocean View districts. The last includes the Lake Merced region, and extends southward to the county line.

The drainage and sewerage problem for this vast area is still further complicated by the city's peculiar topography. Her nature, like her art, is not yet an unmixed blessing. And this truth is illustrated, as far as sewer construction is concerned, by the fact that the sloping ground, hillsides and hilltops, which can be easily drained by gravity flow, are often separated from the low flat areas, where it is almost impossible properly to collect the sewage without the aid of pumps. The unanimity of scientific opinion, however, that the ultimate discharge into the deep waters of the bay or ocean was the only practical method of sewage disposal has greatly aided the solution.

In general terms the present plans call for a combined system of storm water relief outlets, consisting of main conduits, fed by tributaries carrying rain water, a certain amount of soil water entering by leakage, and dilute sewage.

It is expected that this sewage will be rendered quite inoffensive by the small percentage thereof in the outflow. In addition to this combined system there will be separate sanitary systems, disconnected entirely, from the storm water outlets, and discharging into pumping stations, whence the sewage will be sent into the principal relief mains, through which it will be swept on to the various points of outfall. And besides this disconnected system a combination of storm water and sewage carrying ducts is designed for districts that have seemed to the engineers to demand them. Wherever the condition of the old sewers warrants they will be retained to supplement the new system.

Except the great Division street conduit, which is rectangular in shape, all mains throughout the city will be either circular or oval, varying from about 8 feet in diameter for the former to about 3½ by 5¼ feet for the latter. These will all be of reinforced concrete, and in many instances lined with vitirified brick. For the supplementary and sanitary systems ironstone pipe will be used, ranging from 6 inches to 2 feet in diameter.

This separation system was rendered necessary in the Yerba Buena and Mission flat subdistricts by the fact that much of the surface lies below city base. And in most of the ocean slope districts both sewage and storm water will be intercepted and discharged into the ocean at the Point Lobos outfall, where the oceanward flow is away from the beach. As a large part of this beach is a public playground it is imperative to keep it as free as possible from pollution.

The main key to the sewage problem presented by this comprehensive system was founded in the selection of the points of outfall for the various drainage areas. A close study of the tides and their velocities resulted in the choice of the following projections into deep, swift water: Off North point, where a large pumping station and screen house will be situated and where there is a discharge in 36 feet of water at 1,200 feet or more from the water front line; off Hunters point, in a like depth; off the ocean shore, just west of Bakers beach, at the foot of Twenty-seventh avenue; off the foot of Scott street, in at least 36 feet of water, sufficiently far from the shore. When it is considered that about one cubic mile of water passes through the Golden gate each way every day, and that to this vast outflow is added the rivers tributary to the bay, San Franciscans need lose no sleep over the ultimate fate of the sewage.

Providing for the Future

Further than this, two other points have been chosen to provide for the concentration of all sewage reaching the northern city front, should the city outgrow the present plan. These are Fort Point and Point Lobos. The former will receive the sewage from a district comprising the greater part of the residential section and the entire business portion of the city. At Point Lobos the sewage from most of the ocean slope will ultimately be delivered. And the Scott street outfall will take care of the Harbor View district until Fort Point is brought into use for the ultimate discharge. The importance of this latter point sufficiently explains why the greatest possible area will be made tributary to the North Point outfall, and why Hunters point will be permitted to provide for the rest.

The main intersecting sewer of this whole system is what is technically known as the North point outlet. Its position was determined by the outfall at North point, north of Telegraph hill, and the intercepting point on the old line of Mission creek. It will run from Valencia street to Division street at Eighteenth, follow the streets best adapted to the purpose and reach the water front from Sansome street. The sewers from the west and a plentiful number of storm water relief outlets will discharge into it all along its course.

Of the conduits that will carry effluents from each of the storm water outlets to the open water in Channel street or to the bay the chief and most import is the great Division street sewer. This will wend its serpentine course along Division street from Eighteenth to the head of the old Mission creek, or Channel street; and as it is now well under way, with its middle section, known as B, almost completed, a more or less detailed description of its construction may interest the general reader.

Like all the main conduits and storm water sewers in the new system, it is to be built throughout of reinforced concrete and lined on the bottom with vitrified brick. Section A runs from Channel street to Kansas, section B thence to Tenth and section C continues the outlet to Eighteenth and Division. The first two sections are practically identical in construction and dimensions—that is, of three parallel compartments or inverts under a common roof of reinforced concrete. For section C, which does not have to provide for as much volume and velocity of storm water, two compartments of slightly larger dimensions have been found sufficient. A description of section B, the only one near completion, will serve to illustrate the type.

This section, then, crescent shaped, following the line of Division street, is 1,400 feet in length. Its total width from outer wall to outer wall is 32 feet. Through each of its three compartments about seven giants 8 feet 3 inches in height could walk abreast without crushing one another's feet, and such is its strength that the heaviest locomotives of the Western Pacific, whose tracks cross its roof near Ninth street, can pass without disturbing the concrete.

Its ventilation is amply insured by manholes at intervals of about 140 feet. And it is flanked on both sides throughout most of its length by a sanitary system of 12 inch pipes, also well aired by chimney shaped manholes. In its main dimensions and in its power to resist strain it surpasses the famous Cloaca Maxima of Rome, which with its eccentric circles and solid blocks of uncemented stone is still the wonder of the civilized world. The comparatively modern origin of concrete sewerage has as yet furnished no test of the enduring quality of this material for the purpose. But it is believed that unless the action of whatever salt and other chemicals the water to be carried may contain is more serious than it is expected to be, the endurance of San Francisco's new sewerage system will suffice for her development.

That this huge section B has been rushed through to completion in what is said to be the shortest time ever required for a great city contract of similar exactions is due largely to the methods of operation and of inspection employed on the job. Despite many obstacles of unfavorable weather and of experimentation necessitated by lack of precedents the whole work has required less than 10 months.

As shown in the pictures the construction has followed the line of the old sewer that debouched at Channel street. Along this course a huge ditch had to be dug by pick and shovel. Lagging and piles to prevent the sides from caving and to support the outer sheathing for the concrete had to be driven. Often the triple row of piles for the foundation were forced through the heavy planks and brick of the old sewer. The next step was the placing and connection of the iron rods to reinforce the concrete, which was emptied from "buggies" to make the concave bottom of the inverts. Then the reinforcing rods for the walls were set and wired, the mudsills of 2x4's were laid, the wooden forms to hold the concrete in place were stood against the rods, bolted, braced by "spreaders" and "purlines" and finally the concrete walls were poured, tamped and allowed to set. On the wooden tops then adjusted a similar process of forming the reinforced concrete roof of the inverts was begun. At the end of two weeks, the time specified for the "setting" of the concrete, the forms and tops were removed and carried forward to be used for the continuation of the construction. Thus the contractor strove to minimize the waste of time and material as consistently as the requirements of speed and efficiency would permit.

Where Inverts Separate

The most interesting part of the whole work from an engineering viewpoint is shown in the picture of the fork and distribution or equalization chambers at the Tenth street end of the conduit. Here the north invert is separated from the other two and brought around in a curve to meet the sewer that will run along Tenth street to the bay. The chief compartments are continued to the end of the old main and will be merged into section C. All three inverts are widened and heightened at least a foot and a half. Where the branch begins the roof is supported only by two reinforced concrete columns, 16 inches in diameter. Thus in the open space left at the intersection the waters flowing from the Tenth street main and from section C, the Division street extension, will be distributed and sent through the inverts of section B. In the picture the construction and the efficient activity of the carpenters, iron workers and laborers are clearly shown.

To calm the possible fears of all skeptics as to the carrying capacity of these great inverts be it understood that they are made and graded to provide for the torrents from the heaviest rainfall over an area of five square miles in the Mission and Potrero districts. More scientifically expressed, the three compartments will have a carrying capacity of 1,701 second feet and will provide for a velocity of 7.51 feet per second. The one compartment of the Tenth street branch will have a quantity capacity of 620 second feet and a velocity provision of 7.5 feet per second.

Much credit for the progress and effectiveness of the work is due not only to the dynamic superintendent employed by the contractor, but also to the quiet young engineers or active inspectors who care for the city's interests. It is these latter who make the surveys, lay the lines and levels, scan with lynx eyes every detail of the construction and often suggest its practical execution. The Merchants' association, legitimate heir of the Civic league, is also on the job by proxy. Occasionally one of their scouts happens along with a criticism or word of advice, which, if deemed practical, is observed by the inspectors. Thus harmony is the watchword, and the work is rushed as merrily as its unsavory nature and the complex character of the labor employed have permitted. Until recently representatives of many foreign climes were found side by side on the job. Greeks, Italians, Servians, Syrians were mingled with Scotch, Irish, English, Germans, Americans and here and there a Native Son, generally of Irish extraction. But the recent enforcement of the ordinance that all employes on a city contract must be either citizens or able to prove their serious intention of becoming such has eliminated the "foreign" element strictly so called.

In view of all the serious problems involved in this huge sewerage system, and of its benefits to the community, its successful completion should reflect undying credit upon its designers. Before the actual work could be begun, careful studies had to be made of drainage areas, soil water planes, water consumption, rainfall rates, storm water capacities, infiltration, run off rates, grades, and numerous other theoretic and practical details. But the condition of the work already under way seems to insure the satisfactory solution of the most serious problems involved. The progress made in the large intercepting sewers of the east Potrero, in the North beach intercepting sewer, in the tributary main in Fifth, Howard and Sansome streets; in the construction of the Sunset, Richmond and other districts of the city, argues strongly for the efficiency of the present methods of operation. As the system has been planned for an estimated population of a million souls, it is safe to assume that the San Franciscan of the future will have less cause to worry over sewage disposal and will breathe a somewhat more Sabean atmosphere than did his less fortunate predecessor.