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JOSEPH B. STRAUSS,

HIS LIFE AND ACHIEVEMENTS

A

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INTRODUCTION

Joseph B. Strauss startled Cincinnati and the faculty of its University when, as a member of the U. C. graduating class of 1892, he proposed, in his graduation thesis, a plan to build a railroad bridge across the Bering Straits and thus connect the North American continent with Asia.

At the commencement exercises in the old Pike Opera House on Fourth Street (since destroyed by fire) before a crowded house, a bewildered faculty and distinguished group of visitors and speakers, this modest, soft-spoken young graduate unfolded his Utopian dream of the Gargantuan bridge which, he explained, could be built to unite two great continents. It seemed an impossible and preposterous scheme which this young engineering student presented so seriously to his astounded listeners. Since then many men of distinction in science, politics and military affairs have referred to the bridging of the Bering Straits as a world-startling possibility of the future--but certainly the distinction of being the original "Bering Straiter" cannot be taken away from "Joe" Strauss.[1]

Had he suggested, on the night of his graduation, the building of a bridge across the treacherous swirling riptides of the Golden Gate, instead of the Bering Straits, his audience would have been equally bewildered and his professors would have smiled as blandly at Joe the dreamer. The abnormality of such a scheme was too incongruous to contemplate at that time and yet on May 27, 1937 less than half a century later, the Golden Gate Bridge of Joseph

1. Alfred K. Nippert, "Joseph B. Strauss, Crusader--An Appreciation", The Record of Sigma Alpha Epsilon, (March, 1937), 3.

Strauss was to be opened to the American people as the last connecting link of the great highway between Northern and Southern California--a monument to the perseverance and outstanding ability of its creator.

It would be difficult to relate the Herculean efforts that would be necessary to successfully overcome all the obstacles--political, financial and technical, in fifteen years of unceasing work and heart-breaking struggles. A giant in strength of soul, restless in his energy to attain the goal of his dreams, he was to stand a peer among the great engineers of the world's greatest structures.

As the Governor of the State of California formally accepted the 8,981-ft. bridge from the hand of its modest engineer, he was able to tell the world that this tremendous structure was erected above and below the swirling tides of the Pacific--a record in the annals of construction.[2]

When John August Roebling, in 1845, built the two great stone piers for the first suspension bridge in America, which eventually, December 1, 1866, united Ohio and Kentucky by two wire spans across the Ohio River at Cincinnati, little Joe Strauss was not yet born, but in later years the sight of that early structure must have unconsciously created within the boy the first impulses which were to meet their realization at San Francisco.

As a child he saw the Cincinnati Suspension Bridge day by day--he could see it as he played near his ancestral home on Mound Street, he could vision it from his desk at old Hughes

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2. Ibid.

High School, and his eyes would seek the stately towers and graceful wire bows as he gazed from old McMicken College southward toward the Kentucky hills.

It was a far cry from the banks of the Ohio to San Francisco Bay and almost a half century was to elapse for Joe's dream to come true, and that which men of his college days said "can't be done" is today an actuality. Human progress always has been along the lines of the impossible, and lives of today are surrounded by the realization of the impossibility of yesterday. This is true of the physical as well as the spiritual progress of the human race.[3]

Joseph Strauss always was a dreamer, with the idealistic tendencies of a poet. Engineer and poet is an unusual combination, but then this is an unusual man.

Dr. Raymond Walters said, "His doctrine was to build as the ancient Greeks did--for utility and simplicity, in the conviction that beauty would issue from such objectives. His Golden Gate Bridge is a marvelous example of the truth of this doctrine."

"Mr. Strauss had great imagination, amazing persistence, and enormous capacity for sustained application. It was these qualities that made possible the fulfillment of his engineering genius."[4]

The late Dean Herman Schneider said, "Professionally, Joseph Strauss's place in the history of engineering can best be told by the simple statement that he was one of the very great bridge-builders of all time. But he was much more than that. He was a

3. *Ibid.*, p. 4.
4. *The Cincinnati Enquirer*, (May 17, 1938).

poet of merit, a musician of fine feeling, and a human being of deep sympathies."

This rare combination, and I do not recall a parallel to it, made him not only a greatly esteemed scientist-engineer, but also one of the best-loved men I have ever known."[5]

5. Ibid.

PART I

A STUDY OF HIS LIFE

BOYHOOD

Joseph was the youngest of four children and the second son of Raphael and Caroline (Bassmann) Strauss. His mother was a musician of unusual ability, and his father was one of the City's most gifted miniature and portrait painters, a very prominent member of artistic circles.

The elder Strauss came to Cincinnati from Bavaria, Germany in 1854, when but 24 years of age. Possessor of poetic and artistic genius, he followed no master, but, through force of natural ability, commanded first attention, then admiration, and finally became regarded as without an equal in delicate detail work pertaining to his particular line of painting. Patrons flocked to his studio in the Pike Building for a period of over 30 years, and he painted portraits of nearly all the leading citizens of the City, and of many residents of other places. Several of these works attracted most favorable comment, notable those of Governor Bushnell and Frederich H. Alms. At all times his studio was the resort of lovers of the unique in art, and he was the vice-president of the Cincinnati Art Club for many years.[6]

The Strauss family was residing at Ninth and Cutter Streets when young Joseph was born on January 9, 1870, and his boyhood was spent in that fine old German neighborhood. Small in stature, little "Joe" seemed to have inherited his father's artistic and poetic ability and at an early age he also displayed a great

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6. Charles T. Greve, "Raphael Strauss", Centennial History of Cincinnati, (New York: Biographical Publishing Company, 1904).

interest in the sciences and mechanics.

After his primary education in the public grade schools, he attended old Hughes High School on East Fifth Street. Here he first evidenced the inventive genius that was to make him famous.

The boys of Hughes, after their graduation, spent a day at the home of Dr. Walter G. Musekamp. The question was asked what each member of the class intended to do. Joseph Strauss, who was the most diminutive member of the class, indicated some uncertainty, but expressed the definite hope that he would accomplish something that had never been done before.[7]

He entered the University of Cincinnati the following fall at the age of nineteen. Indefatigable as a student of engineering under two great teachers, Thomas Eddy and Ward Baldwin, he showed a marked inventive skill in contriving various experimental devices and installing electrical apparatus, as well as being a wizard at mathematics, science and mechanics. Small of stature, great of mind, young Joseph was a leader of men--a miniature Napoleon (though not a bloody one)--on his college campus and super-active as an organizer of student activities.

As early as 1889, he became interested in the establishment of Sigma Alpha Epsilon on the Cincinnati campus, and he helped to found the Ohio Epsilon chapter as representing the second great national Greek-letter fraternity at U. C.--a chapter that was to furnish many outstanding business, industrial and professional leaders throughout the nation.[8]

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7. Enquirer, (May 17, 1938).
8. Nippert, op. cit., p. 3.

Yet "Joe" Strauss himself might never have attained the heights of success, had it not been for an apparently trivial incident one fall afternoon in 1889, his sophomore year:

On this particular day, he decided to try out for the football team. Barely five feet in stature, light of build, little "Joe" was the very opposite of the hulking giants they desired for football material in those days. The squad laughed when he took his place in the line. An oversized suit made him appear even smaller than he actually was. The big boys on the team took delight in tossing him about during the ensuing scrimmage. At the end of the afternoon workout, the plucky sophomore was a patient in the infirmary.

"You're a good sport, Strauss," said the coach, "but you can't play football. You're just too darn little."

In the hospital, "Joe" Strauss brooded over the dirty trick fate had played on him when she made him "just too darn little". He emerged with a new obsession which shaped his whole life and career. He wanted, somehow, sometime, to build the biggest thing in the world. Since a bridge is the biggest thing a man can build, "Joe" Strauss made up his mind to be a bridge engineer.[9]

As his senior year rolled around, this young man found himself not only president of the class of 1892, but also class poet. He proved his poetical talents to be of no mean caliber when, at the class day exercises, he presented his "Reveries", which, in spiritual depth and artistic qualities, has never

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9. Frank J. Taylor, "A Matter of Size", American Magazine CXIX, (January, 1935), 86.

been equalled by any class at old U. C. in 'lo these many years. It consisted of a philosophical view of man's life as subjected to the forces of nature and the influence of human society. The following two verses, picked at random out of the twenty-one constituting the poem, will demonstrate "Joe's" ability as a worthy rider of Pegasus:[10]

The moon, companion to nocturnal thought,
Pours out her light of mirrored sunbeams wrought;
Maternal spreads her robes of mellow white
Far over lowland plain and rugged height;
Dims, by her nearer splendor, younder host,
Whose multicolored orbs do seem almost
Like flick'ring beacon lamps that silent burn
On distant shores, round which they bend and turn
In straggling lines of warning light,
That flash their signals through the night.

Among those myriad millions hung in space,
Finds, too, this tiny world of ours a place;
From it tonight how small a part I see
Of its known stellar fellowship; to me
They bring the consciousness of those unknown,
Whose light our skies can never hope to own;
Whose course is laid where eye nor mind can reach;
Where trains of regal courtiers follow each,
In systems vast, with centers yet
Far deeper in creation set.

10. Nippert, op. cit., p. 3.

MANHOOD

Upon graduation, young Strauss entered the employ of the New Jersey Steel & Iron Company as a draftsman. This concern was a foundry which specialized in bridge materials.

In 1894, he returned to his home town and his alma mater, becoming an instructor in engineering at U. C..

After a year of teaching, Strauss obtained a job with the Lassig Bridge & Iron Company of Chicago, where, from 1895 to 1897, he worked successively as a detailer, inspector, estimator and designer.

It was in Chicago on June 9, 1895 that the young engineer was married to May Van, daughter of Charles Van, of Cincinnati.

From 1897 to 1899 Strauss was a designer and squad boss in the Sanitary District of Chicago.

In 1899, he became principal assistant engineer in charge of the Chicago office of the consulting engineer, Ralph Modjeski.

The Chicago of that period was full of opportunities for bridge engineers, and Strauss seized the chance to study bridges and viaducts. He helped design railroad bridges, some of which had to be drawbridges. Most of these were of the old turnstile type--slow to swing open and to close. Also, they required the building of a large, costly pier in mid-stream.

It was in this field that Strauss came in contact with the new art of bascule bridge design, being assigned to the task of revising and redesigning the early types then just introduced to a limited extent in Chicago. When Strauss's attention was directed to bascule bridges, they were comparatively rare. Although they had the advantage of lifting quickly to permit the passage of ships, they were limited in length, as well as being costly. The necessity of short spans was due to operating difficulties caused by the excessive weight of the cast-iron counterweights, but a principal objection was the expense of these counterweights.[11]

One day in 1902, Joseph Strauss submitted to his firm a plan for making the counterweight of concrete, instead of pig iron. That meant counterweights of large bulk, but of greatly reduced cost. To permit large-bulk counterweights to function without interference and infringement on the supporting structure, he developed the pin-connected or parallel-link counterweight system, a radical departure from conventional practice.

However, his new idea was ridiculed by his superiors and summarily thrown out. Whereupon, the determined young engineer resigned, put on his hat, walked down the street, rented an office, and set himself up in the bridge-building business.

The Wheeling and Lake Erie Railroad agreed to let the young inventor build one of his new-idea bridges at Cleveland, with the understanding that if it failed to work, the experiment would be at his own expense. Scraping together all the money he could beg or borrow, he built the first Strauss bascule bridge. It was designed with a counterweight of iron-ore slag, carried in a reinforced concrete box or container. He awaited anxiously the day when he could throw the switch and

11. Dictionary of American Biography, (New York: Charles Scribner's Sons, 1958), XXII, 636.

watch the machinery drop the 150-ft. single-track span into place.[12]

Bridge history was made that day. The mechanism worked like magic. Its simplified operation effected a marked decrease in the cost of constructing bascule bridges and a corresponding expansion of their range of application and the size and weight of spans. Because of its economy, the Strauss bascule revolutionized bridge-building.

In the second bridge Strauss built, he constructed the counterweight as a homogeneous, self-supporting, concrete beam pivotally connected to the "tail end", or counterbalance arm of each truss. This type of concrete counterweight was immediately adopted by all designers of bascule and other types of lift bridges and completely superseded cast-iron counterweights.[13]

The success of Strauss's early designs led him to concentrate for a period upon the bascule bridge. In less than seven years, he produced four different types, known respectively as the heel trunnion, the vertical overhead counterweight, the underneath counterweight and the simple span type.[14]

He also developed new types of vertical-lift bridges, including one in which the operating cables were replaced by a rack-and-pinion drive, producing a safer and better structure.

Now the world came to Joseph Strauss for bridges. His

12. Taylor, op. cit., p. 87.
13. The National Cyclopaedia of American Biography, (New York: James T. White & Company, 1939), XXVII, 31.
14. These four types of bascule bridges are described in detail in another part of this report.

Strauss Bascule Bridge Company, of Chicago, later known as the Strauss Engineering Corporation, became one of the leading consulting firms in the country. In a few years, he had designed and built bridges in virtually every state in the Union, and in many foreign lands. Some of his designs were chosen in international competitions. He established new records for length of span and weight of bascule bridge.

The longest single-leaf Strauss bascule bridge is one carrying the St. Charles Air Line Ry. over the Chicago River at 16th St., Chicago, Ill.. It has a span of 260 ft. from center of trunnion to center of end bearing. Its weight is 7,100,000 lb., including the counterweight. It has two through trusses spaced 32 ft. 4 in. between centers. The operating machinery weighs 139 tons, including two 150-hp. electric motors.[15]

The heaviest single-leaf Strauss bascule bridge is that of the Baltimore & Ohio R. R. over the Calumet River at South Chicago, which was completed in 1914. The span is 235 ft. from center of trunnion to center of end bearing, and the weight is 7,600,000 lb., including the counterweight. It is a through bridge with two trusses spaced at 31 ft. 3 in. centers. For its operation, there are two 140-hp. electric motors, and the weight of machinery is 125 tons.[16]

The longest double-leaf Strauss bascule bridge is that carrying the Canadian Pacific Ry. over the U. S. Ship Canal at Sault Ste. Marie, Mich.. This was also completed in 1914.

15. "Modern Drawbridges Attain Great Weights and Spans", Engineering News-Record, (1919), LXXX, 860.

16. Ibid.

It has a span of 336 ft. between trunnions, and is a through bridge with trusses spaced at 20 ft. centers. The weight including counterweights is 7,500,000 lb.. The operating machinery weighs 138½ tons, and includes four 40-hp. electric motors.[17]

The heaviest double-leaf Strauss bascule bridge is the beautiful structure which spans the Neva River at Petrograd in Russia, to the former Winter Palace of the Czar. This famed bridge was completed in 1915 during the ill-fated reign of Nicholas II. It weighs 8,400,000 lb. including the counterweight. Its span is 208 ft. 8 in., and its width 91 ft. 3 in., with eight lines of through trusses. It carries a highway and an electric railway. There are four 40-hp. electric motors. The total weight of machinery is 455 tons. This includes machinery necessary to relieve the load of the counterweight from the counterweight trunnion when the bridge is closed, so that the bridge in this position will act as a three-hinged arch.[18]

The Burnside Bridge at Portland, Ore. is a splendid example of the Strauss bascule. This underneath counterweight double-leaf cantilever (the graceful deck-arch highway type) is 252 ft. center to center of trunnions and 83 ft. wide, and carrys a concrete deck.

Strauss designed the Outer Drive Bridge in Chicago, a double-leaf bascule over the mouth of the Chicago River. This remarkable structure has a span of 264 ft., a width of 108 ft., and provisions for a double deck.

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17. _Ibid._
18. _Ibid._

Strauss introduced ribbed concrete arch bridges into the United States, building them without falsework. His concrete arch bridge at Belvidere, Ill. has been featured in standard works on concrete construction.

He was in charge of design and construction of the Illinois River Bridge at Peoria, Ill.; the Mississippi River Bridge at Quincy, Ill.; the Independence-Liberty Bridge across the Missouri River; and the Columbia River Bridge at Longview, Wash., the largest cantilever structure in the United States, completed in 1930.

He was co-designer of the $12,000,000 Montreal-South Shore Bridge which was built for the Montreal Harbor Commission. This, the longest highway bridge in Canada, was designed by Strauss, in conjunction with a firm of Canadian engineers, in 1930.

He was consulting engineer to the United States Government for the drawspan of the $10,000,000 Arlington Memorial Bridge across the Potomac River in Washington, D. C., one of the most beautiful bridges in the world. It was constructed in 1932.

Strauss was consulting engineer to the Port of New York Authority on the $75,000,000 3,500 ft. George Washington Bridge over the Hudson River at 179th St. in New York City. He served in the same capacity for the construction of the $18,000,000 1,650 ft. Bayonne, New Jersey.

He was a consultant to the Republic of Panama on highway bridges, to the government of Cuba, Santo Domingo, Norway, Denmark, China, and to the Egyptian State Railways. He was called to Japan to build a magnificent structure at Osaka.

He designed bridges that were engineering triumphs throughout Europe, Asia and South America.

In his lifetime, Joseph Strauss built almost 500 bridges. The $27,000,000 Golden Gate Bridge with the longest span in the world--4,200 ft., was his last and crowning achievement.

Into his work went remarkable ability and intense concentration, yet for all the demands of his career, there was enough of the man's heart and mind to be shared with his fellow men. Interested in the welfare of transient youths, he was chairman of the Citizens' Training Corps Committee of San Francisco that planned a nation-wide movement for the training of youths.

This committee, jointly with the State Emergency Relief Administration of California, conducted its first experimental school in citizenship and physical and vocational training at Clyde, California in the summer of 1935. The work was limited to transient boys on relief and proved so successful that the committee arranged to ask the forthcoming Administration at Washington to support the new program in a manner similar to the Civilian Conservation Corps.

"The two movements are complimentary," Strauss stated in a letter to a Cincinnati friend. He said the six months' operation of the experimental unit at Clyde "demonstrated the complete success of the work."

"For this experimental unit we limited ourselves to transient boys on relief," he wrote. "In view of the current need we propose to re-establish the Corps as a non-political, non-sectarian, twenty-four-hour school for boys between the ages of 16 and 19, who, due to their family background, lack normal opportunities for social and educational development, and for transient boys now on relief who are neither employed, nor attending school. Eventually we aim to extend the school to include a cross-section of American youth."

"These results prompted the Citizens' Training Corps Committee to take steps for establishment of the Corps on a permanent and national basis, but under local administrative control."

The plan of the Corps contemplated establishment of Citizens' Training Academies in each state to guide and adjust youth in meeting the problems of approaching manhood, and to turn out well-rounded youth willing and able to take their places in society.

Not more than five hundred selected youths between 16 and 21 would be enrolled annually in each academy. They would be known as citizen-cadets and would be required to remain at least one year. The program would include vocational training, recreation and reasonable discipline for character development. At completion of the training course, each student would receive a citizenship certificate.

The aim would be to raise the level of citizenship by establishing self-reliance, self-respect, understanding and manliness, creating standards of honor, loyalty and duty, and building up traditions of comradeship and fellowship. A department would be maintained to help the graduates find employment in industry, agriculture or government service.[19]

Strauss's versatility as an inventor is reflected in many patented devices which pioneered technical advances in various fields. He designed and built the Aeroscope for the 1915 Panama-Pacific Exposition in San Francisco. He developed a type of concrete stock house for the Universal Portland Cement Co. and a series of reinforced concrete freoght cars--a World War I emergency measure. He designed the basoule door hangar built by the governments of the United States and Mexico, a system of rapid transit known as the Airtram, a system and a unique type of rotating tower restaurant. He originated, pioneered and built the yielding barrier--the first practical device ever designed to stop automobiles at railway grade crossings. He designed a number of portable searchlight outfits used by the United States and Russia in World War I, and he constructed a disappearing observation tower at Ft. Hancock, New York.[20]

Strauss was a member of the following organizations: American Association of Port Authorities, American Railway Engineering Association, American Society for Testing Materials, American Society of Mechanical Engineers, American Society of Military Engineers, Corporation of Professional Engineers of Quebec, Engineering Institute of Canada, Western Society of Engineers, International Rotary Club of Chicago, Los Angeles

19. The Cincinnati Time-Star, July 28, 1936.
20. Many of these inventions are described in more detail in another part of this report.

Athletic Club, Chicago Association of Commerce, Royal Society of Fine Arts (England) and Sigma Alpha Epsilon.

Over and above all else, Joseph Strauss remained faithful to the rhyming gift that was his. He contributed to many magazines and was the author of a monograph entitled "It Can't Be Done", and of many poems which appeared in various anthologies, particularly "American States Anthology," "Poems of Courage" and "Yearbook of Contemporary Poetry for 1937." His poem, "The Redwoods", written in 1932 and published as a song, was characterized as "one of the most beautiful examples of modern music." He also wrote "Flags Aloft", dedicated to the U. S. Military Academy and "America, Our Own, Our All", both of which were set to music.

The following epic poem,[21] dedicated to the completed Golden Gate Bridge, reflects the sublime spirit and immovable faith of its designer, builder and chief engineer:

At last the mighty task is done;
Resplendent in the western sun,
   The Bridge looms mountain high;
Its Titan piers grip ocean floor,
Its great steel arms link shore with shore,
   Its towers pierce the sky.

On its broad decks, in rightful pride,
The world in swift parade shall ride
   Throughout all time to be;
Beneath, fleet ships from every port,
Vast landlocked bay, historic fort,
   And dwarfing all--the sea.

To North, the Redwood Empire's gates,
To South, a happy playground waits,
   In rapturous appeal;

21. "At Last the Mighty Task is Done", The Record of Sigma Alpha Epsilon, (March, 1940), 230.

Here Nature, free since time began,
Yields to the restless moods of Man,
   Accepts his bonds of steel.

Launched 'midst a thousand hopes and fears,
Damned by a thousand hostile sneers,
   Yet ne'er its course was stayed;
But ask of those who met the foe,
Who stood alone when faith was low,
   Ask them the price they paid.

Ask of the steel, each strut and wire,
Ask of the searching, purging fire,
   That marked their natal hour;
Ask of the mind, the hand, the heart,
Ask of each single stalwart part,
   What gave it force and power.

An honored cause and nobly fought,
And that which they so bravely wrought,
   Now glorifies their deed;
No selfish urge shall stain its life,
Nor envy, greed, intrigue, nor strife,
   Nor false, ignoble creed.

High overhead its lights shall gleam;
Far, far below life's restless stream
   Unceasingly shall flow;
For thus was spun its lithe fine form,
To fear not war, nor time, nor storm,
   For Fate had meant it so.

PART II

A DISCUSSION OF HIS INVENTIONS

AIR TRAM SYSTEM OF TRANSPORTATION[22]

While still engaged in supervising the finishing stages of the construction of the Golden Gate Bridge, Joseph Strauss was called upon to act as consultant for a group of business and financial leaders who were trying to work out a plan to solve the traffic problem of Los Angeles. At a meeting in 1937, he outlined proposals for an ultramodern rapid transit system of either elevated streamlined railways or elevated bus lines.[23]

The following is a description of one type of tramway system which he developed:

Referring to the accompanying drawings:

Fig. 1 is a front view of the Air Tram system construction.

Fig. 2 is a plan view showing the lateràlbracing system and with the tops of the U portals removed.

Fig. 3 is a sectional view through the central main girder showing the bracket connections.

Fig. 4 is a view of the means of connecting the brackets and main girders with the posts.

The construction consists of a series of posts at intervals, separated just far enough to clear the car. When two tracks are arranged side by side, the intermediate posts act for both tracks. As shown in Figs. 1 and 2, the posts 1, 2 and 3 are connected together at their tops by portal girders which are termed U-portals. Each post 1 has a laterally projecting cantilever bracket 4 connected with it. The post 2 has the brackets 5 and 6, and the

22 U. S. Patent No. 2,023,906, (Dec. 10, 1935).
23 *The Record*, (March, 1937), p. 4.

post 3 has the bracket 7. The brackets 4 and 5 have a space between them. On the adjacent ends of these brackets are the track-supporting stringers 8 carrying the rails 8a for the trucks, and on the adjacent ends of the brackets 6 and 7 are the stringers 9 carrying the rails 9a.

Mounted upon the bracket 4 is the angle member 10, and mounted upon the bracket 5 is the angle member 11. These angle members meet at 12 and are connected together and form a U-portal projecting above the tops of the vertical posts. These angle members have the openings 13 and 14 for conduits, wires, etc. The ends of the brackets 4 and 5 project beyond the angle members 10 and 11 as shown. There are a series of these U-portals at proper intervals, each having an open passageway through it for the trucks which run on the rails 8a. Mounted upon the bracket 6 is the angle member 15, and mounted upon the bracket 7 is the angle member 16, their adjacent ends being connected together at 17. These brackets form a similar U-portal and have the openings 18 and 19 for conduits, wires, etc. They also have the open passageway for the trucks.

Mounted within the open passageways through these U-portals are the trucks 20, from which the cars 21 are suspended by the hangar connection 22. The rails are supported by a series of these U-portals and associated parts separated at proper distances. In addition to being connected transversely at their tops by these bolster girders, the posts are connected longitudinally by the carrying girders 23, 24 and 25.

In Fig. 1 is illustrated the construction at a point where it crosses highways, railways, etc. At these points the posts

1, 2 and 3 are made longer and are further connected crosswise by the members 26 and 27. This gives ample space below the cars for the vehicles on the highways or railways and makes a construction where there is no interference between the Air Tram system and these highways and railways.

At points where there are no crossroads or railroads, the posts will be shorter, being of sufficient length to keep the bottom of the cars from striking the ground, and in that event the braces 26 and 27 will be omitted. The bottom faces of the cantilever brackets 4, 5, 6 and 7 are inclined upwardly from the posts toward the rails, giving more room for the cars. There is a longitudinal lateral system for bracing and strengthening the construction and arranged so as not to interfere with the trucks or cars.

This lateral system of bracing is shown in Fig. 2 in connection with one set of posts 1 and 2, it being understood that a similar bracing would be provided between posts 2 and 3. This bracing is shown as being in the plane of the track stringers 8 and consisting of the members 28 which extend diagonally or at an angle between the cantilever brackets 4, the track stringers 8 and the longitudinal girders 23. Similar lateral bracing members 29 are arranged between the cantilever brackets 11, the track stringers 8 and the longitudinal girders 24.

By means of this construction the U-portals have an open space within them wider than the space between the cantilever members or brackets, and that whereas the structure is braced both transversely and longitudinally, there are still provided three continuous passageways, as it were, one through the U-portals for the trucks, one between the posts for the cars hung below the rails, and one between the cantilever brackets for the hangers connecting the cars to the trucks.

Fig.1

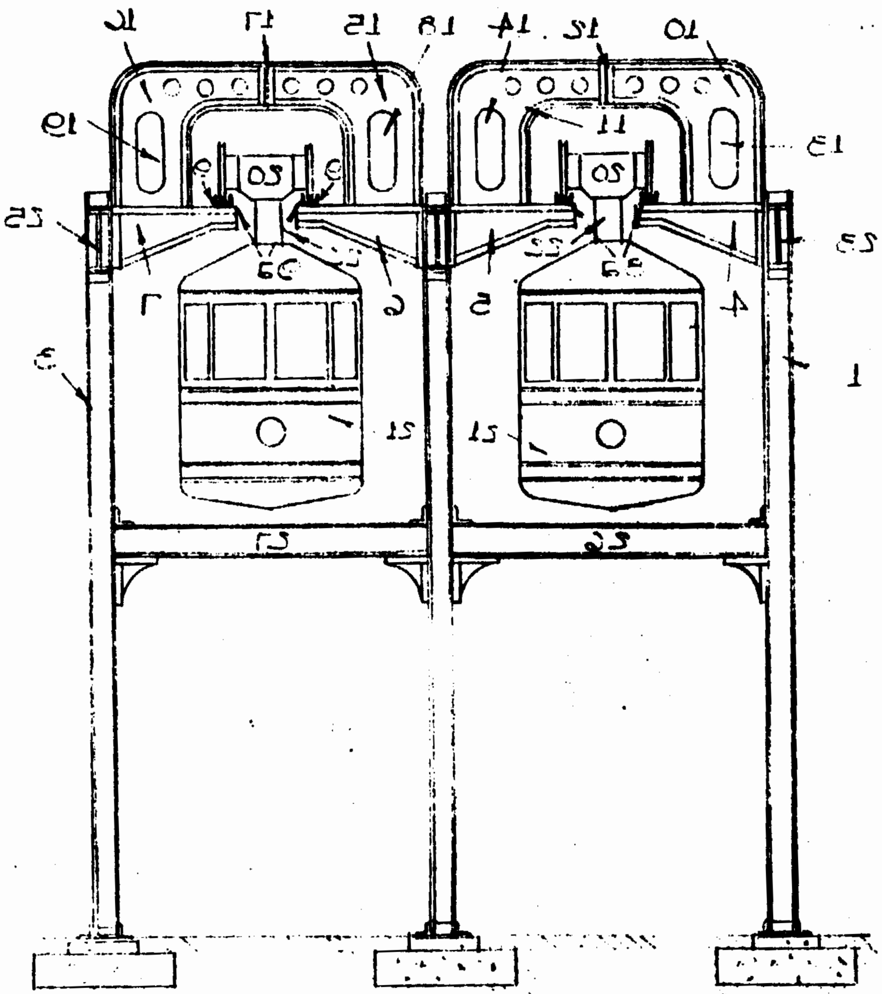


Fig.2

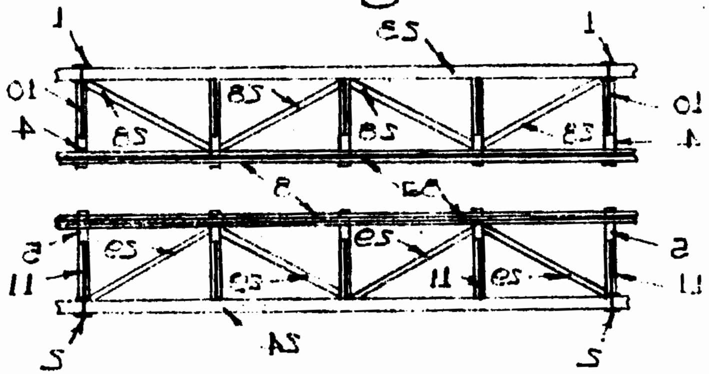


Fig.3

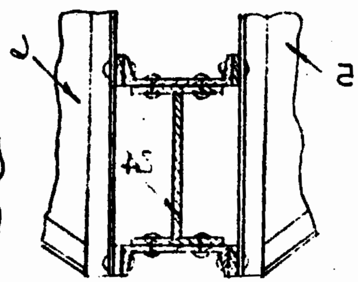
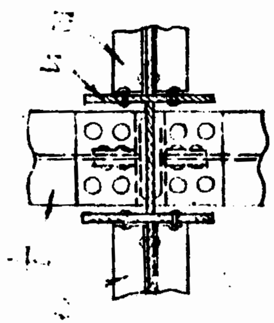


Fig.4



Air Tram System of Transportation

SUBWAY TRAMWAY CONSTRUCTION[24]

This is a variation of the Air-Tram system of transportation which Joseph Strauss developed. As shown in Fig. 1, this construction consists of a subway built under the street, or at other points, and provided with the car passageways 1 and 2 and at intervals along the center of the subway with the supports 3. This support may be continuous if desired. The roof sections 4 and 5 of the subway, on which the street may be laid, are supported by girders 6 and 7. These girders are of inverted U-shape or steel brackets having their lower ends carried by the supports 8 and 9. Cantilevered members 10 extend inwardly from the bottom of the girder 7 and carry the rails 11, upon which the wheels 12 of the trucks run, which support the cars 13. The girder 6 has similarly inwardly projecting cantilevered members 14, which carry the rails 15 in a similar manner.

At each side of the tunnel are arranged inspection galleries 16 and 17 which communicate with the main subway by means of openings 18 and 19. Above these galleries are conduits 20 and 21 for conductors, cables, pipes and the like. There is also a gallery 22 between the two tracks which have openings 23 and 24. These galleries are particularly useful for maintenance and inspection purposes.

In Fig. 2 is shown a sectional view at a station. In this construction the subway is enlarged at the sides so as to form the station compartments 25 and 26, having the station platforms 27 and 28, and the platforms 29 and 30 extending into the main

[24] U. S. Patent No. 2,013,703, (Sept. 10, 1935).

subway, and by means of which the passengers pass into and out of the cars.

By this means of construction, in which the roof girders become the supporting girders for the Air Tram system, great economy is effected, and this also decreases the depth to which the subways must be excavated, providing a further saving in cost. It will also be seen that by this arrangement the Air Tram cars may pass from the structures in the open air into the subways and out of the subways back to such open air structures.

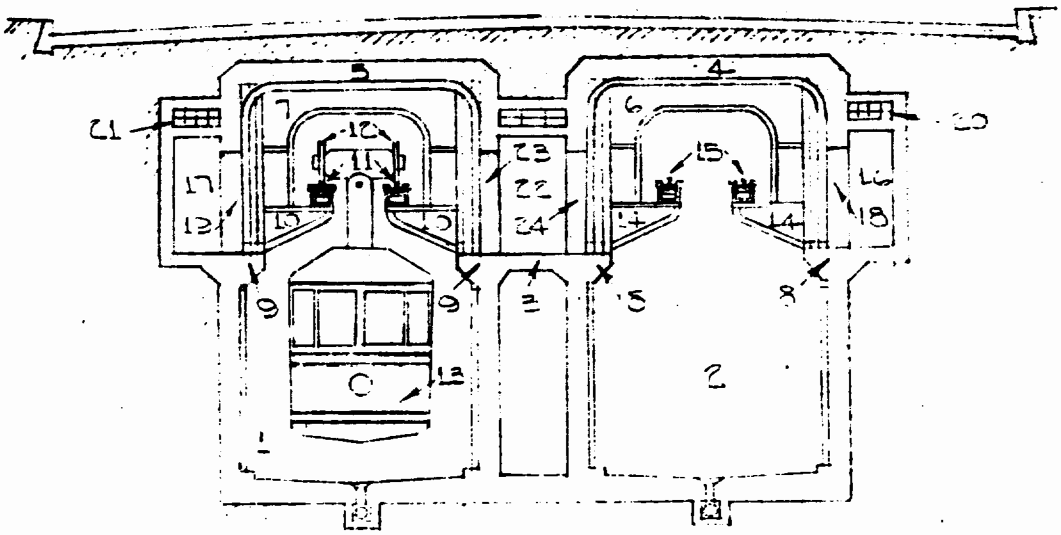


Fig. 1

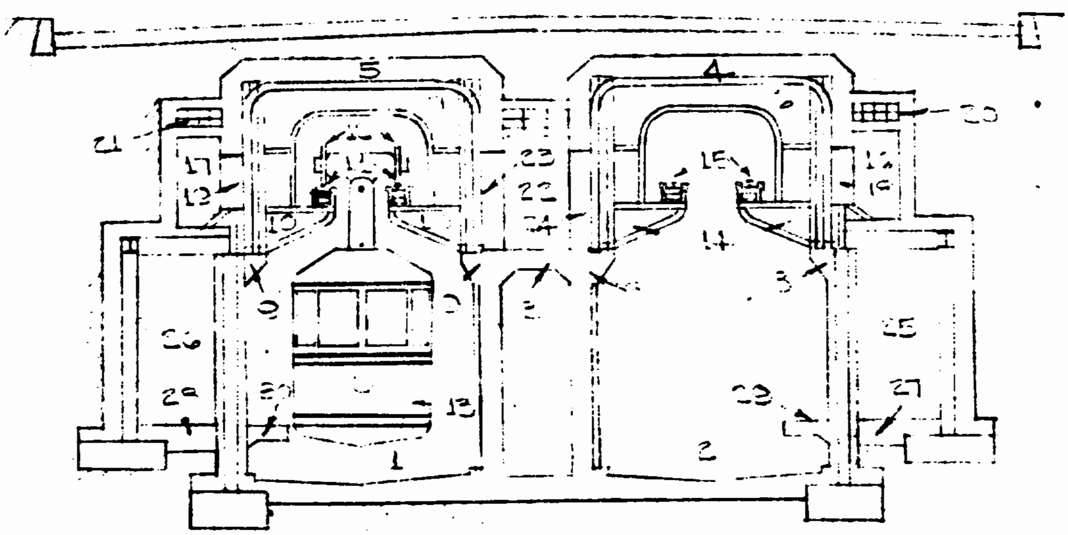


Fig. 2

Subway Tramway Construction

YIELDING BARRIER FOR VEHICLES[25]

This device, adapted to be out of the way when not in use, is controlled automatically and when struck by a vehicle, gradually stops it without injuring either the vehicle or the occupants. Joseph Strauss patented it in 1931, and by 1939 it was credited with preventing eighty-six automobile accidents and probably saving twice that many lives.[26]

The principle by which it worked was later employed by the U. S. Navy to stop airplanes when they landed on carrier decks.

Referring to the accompanying drawings:

Fig. 1 is a front view of the barrier construction.

Fig. 2 is an enlarged view of one of the supports.

Fig. 3 is a front view of the device shown in Fig. 2.

Fig. 4 is an enlarged detail showing the end of the lifting cable.

Fig. 5 is a sectional view taken on line 5-5 of Fig. 3.

Fig. 6 is a longitudinal sectional view through one of the drums with the brakes and cable omitted.

Fig. 7 is a plan view of the barrier and associated parts.

Posts or supports 1 are provided on opposite sides of the roadway. Between these posts extends a flexible obstructing device 2 which can be raised so as to be out of the way and lowered so as to extend across the roadway and be engaged by any vehicle attempting to pass. This flexible obstructing device is made in the form of a network. Connected to it at each end are

25. U. S. Patent No. 1,652,186, (Dec. 13, 1927) and U. S. Patent No. 1,818,824, (Aug. 11, 1931).
26. The Record, (May, 1939), p. 96.

flexible cables 3. These cables are wound around drums 4 as shown in Figs. 3, 4 and 5. When the device is struck by a vehicle, the pressure on it unwinds the cables from the drums and permits the device to move forward with the vehicle. Some means is provided for resisting this forward movement so as to bring the vehicle to a stop.

The drums are provided with brakes at both ends which resist their rotation, and these brakes are automatically applied by the pressure of the vehicle on the obstructing device. As shown in Figs. 3, 4 and 5, the brake drums are engaged by the braking elements 6 and 7, pivoted at 8 and 9, and provided with the retracting spring 10.

The braking element 6 is connected with a member 11 which is pivoted to the lever 13. This member has a guide 12 over which the cable passes. The lever is pivoted at 14 between its ends and is connected with a link 15 which is pivoted to the brake member 7. All of the drums are provided with this arrangement.

When the obstructing device is struck by the vehicle and the cables begin to pay out, there will be a pressure applied to the guide 12 and hence to the pivoted member 11, tending to pull it toward the lever 13. This clamps the brake element 6. The pressure of the pivoted member on the lever rocks it about its pivot, and by means of the links 15 clamps the brake member 7 on the brake drum. Thus, the braking action is automatic and the greater the pressure, the greater the braking action will be. This construction also permits the obstructing device to gradually move under the impact of the vehicle, and it will be gradually stopped so as to halt the vehicle without injuring it or the passengers.

A mechanism is provided for retracting the drums when the pressure from the obstructing device is relieved. This device consists of a retracting spring 4a as shown in Fig. 6. One end of the spring is connected with the drum and the other end with a non-rotating part 4b upon which the drum is mounted. The drums and the braking apparatus on each post are carried by a part 17 which slides along the sides 18 of the post as shown in Fig. 5. This part is operated by a mechanism so that the obstructing device can be lifted out of the way and lowered across the roadway when desired.

This lifting mechanism comprises a cable 19 which has its ends connected to the sliding device at 20 and 21 as shown in Fig. 3. This cable passes over the pulleys 22 and 23 at the top and bottom of the posts.

A motor 24 is connected by a belt 24a on a pulley 23a of the motor shaft. This belt engages a pulley 24b on the shaft 24c. This shaft is connected with the shaft 26 by a worm 26a which engages a worm gear 26b on it. The gear 25 which is operated from the shaft 26 controls a limiting switch as shown in Fig. 2. When the motor is rotated in one direction, the sliding devices, drums and brakes will be moved up so as to lift the obstructing device out of the way as shown in dotted lines in Fig. 2. When the motor turns in the other direction the various parts will be moved downwardly so as to drop the device across the roadway.

A mechanism is provided for automatically lowering the obstructing device before the train reaches the crossing and automatically raising it after the train passes.

A warning signal is provided for drivers of vehicles on the road and also an indicating signal which tells the engineer of the train whether or not the device is operating. This arrangement is shown diagrammatically in Fig. 7. The yielding barrier is located on opposite sides of the crossing 28. Along the track are sets of conducting rails 29 and 30, which are insulated from the ground and are resting on the wood ties 31. These rails are shown diagrammatically, and it is understood that in practice they will be so positioned that a train will not be on the two sets of rails on opposite sides of the crossing at one time, that is, so that the train will not connected these two sets of rails.

When a train which may be of one or several cars is moving in the direction of the arrow in Fig. 7 and comes in contact with the rails 29, a circuit is completed. All the electric motors are set in operation in one direction so as to act to positively move the obstructing barriers and the arms 32 on each side of the railway down to their operative positions. At the same time the signalling device 33 is actuated.

When the train passes from the rails 29 to the rails 30, the old circuit is broken and a new circuit is completed. The current then travels through all the motors in the opposite direction and they are actuated to positively lift the obstructing devices and the arms to their inoperative positions. When the train leaves the rails 30, the new circuit is broken.

Since the obstructing device moves bodily downward while the warning arms move around a pivot, this makes a vivid and complete impression of the two devices on the eye of the party coming along the road in an automobile. Whereas, if they were both pivoted, he might think they were practically the same thing. This indication to him that there are two distinct and different things in front of him tends to make such an impression before him that he will slow up his automobile and if he does strike the barrier, it will be with less force than might otherwise be the case.

Notice also that the barriers are moved down to their operative positions positively and directly by the train and wholly independent of their weight. They would be moved downwardly not only if the weight was removed, but also if there was an obstruction in the way which resisted the downward movement. Thus, the downward movement of the barriers to their operative positions is assured under all conditions and this is the vitally important thing with such a device. If it is moved down to its operative position positively and without fail, it will stop the automobile and save the lives.

AEROSCOPE[27]

Referring to the accompanying drawings:

Fig. 1 is a plan view of the Aeroscope.

Fig. 2 is a side elevation.

Fig. 3 is a sectional view taken on line 3-3 of Fig. 2 with parts omitted.

Fig. 4 is a sectional view taken on line 4-4 of Fig. 2.

Fig. 5 is a bottom view of the car.

This interesting device consists of a supporting tower 1, upon which is rotatably mounted an arm 2, carrying on its outer end a car 3. The tower is arranged so that it may be rotated by means of a circular rack 4 and a motor 5. The arm is carried by a shaft 6 which is mounted upon the tower. This shaft is provided with a brake wheel 7, having a brake shoe 8, which is controlled by a lever 9 arranged so that the arm may be held in any desired position.

A counterweight 10 is adjustably connected with the arm and movable with relation to it. Carried by the guides 11, the counterweight is moved by means of a screw 12, working in a threaded opening and actuated by a motor 13. This motor may be controlled by the operator on the car by means of the electrical conductors 13a. By moving the counterweight in or out, the arm may be properly balanced as the number of passengers in the car varies.

The arm is adapted to be moved about its point of support. As the device is properly balanced by means of the counterweight, very little force will be required to move it. This movement is

27. U. S. Patent No. 1,235,506, (July 31, 1917).

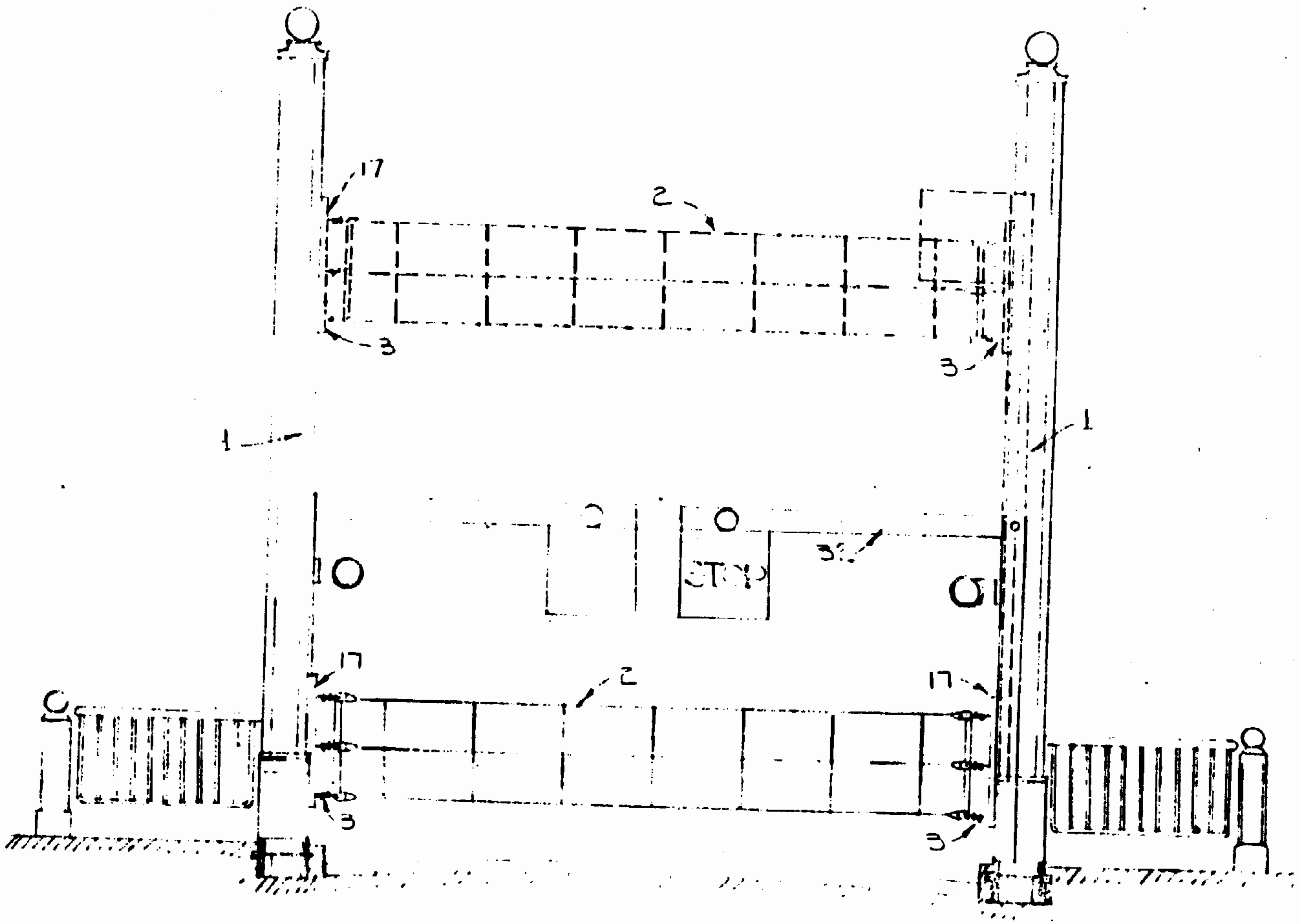


Fig. 1

Yielding Barrier for Vehicles

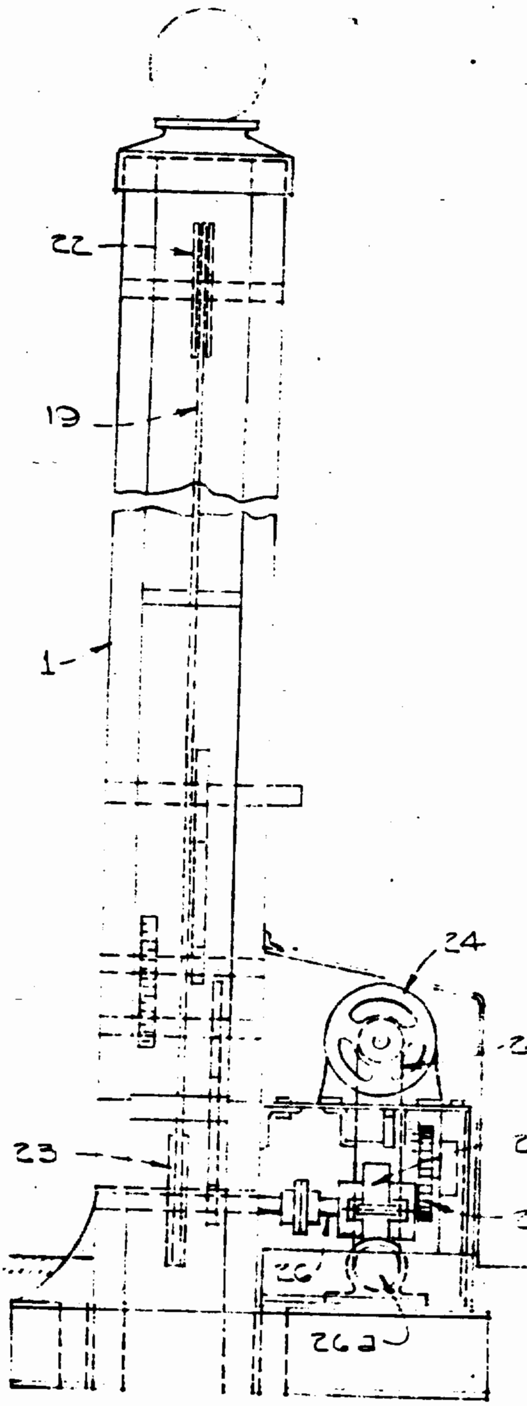

22
19
1
24
24a
23
26b
25
26
26a

Fig. 2

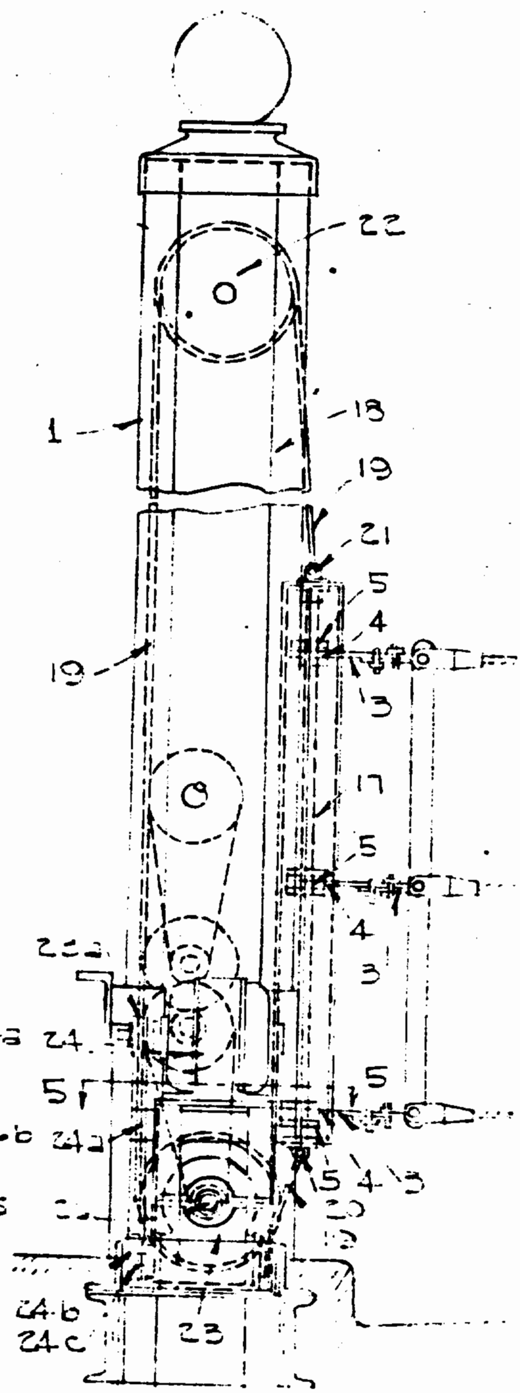
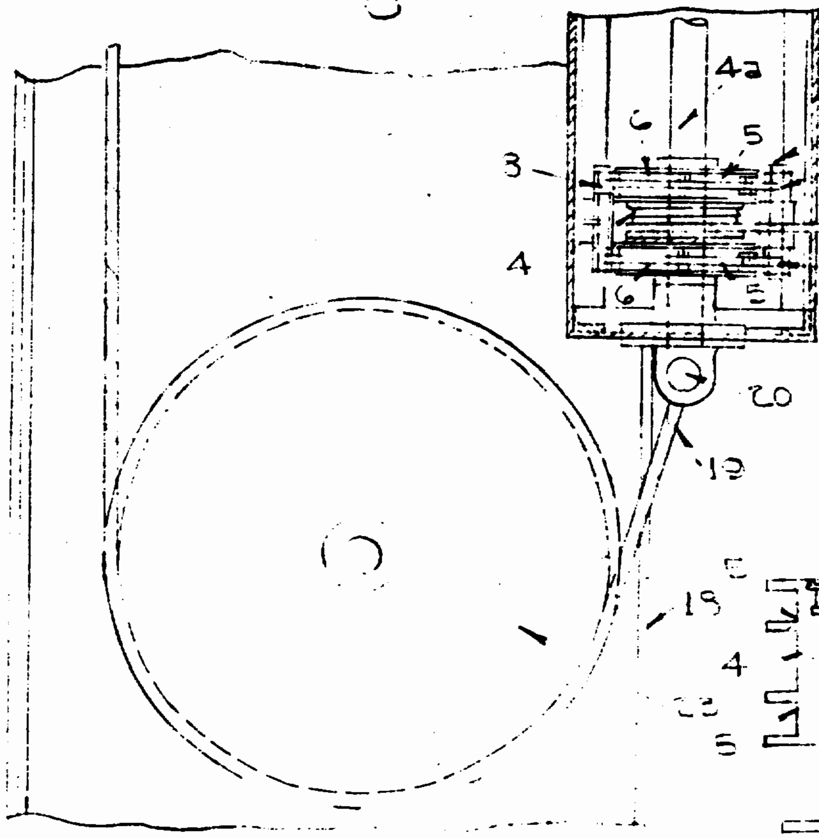

22
1
18
19
21
5
4
6
3
17
22a
24
24a
23
24b
24c

Fig. 3

Fig. 4



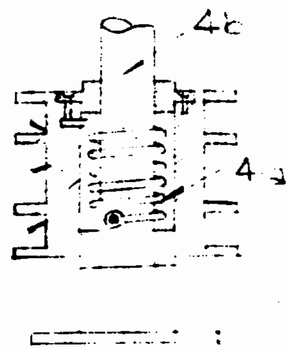


Fig. 6

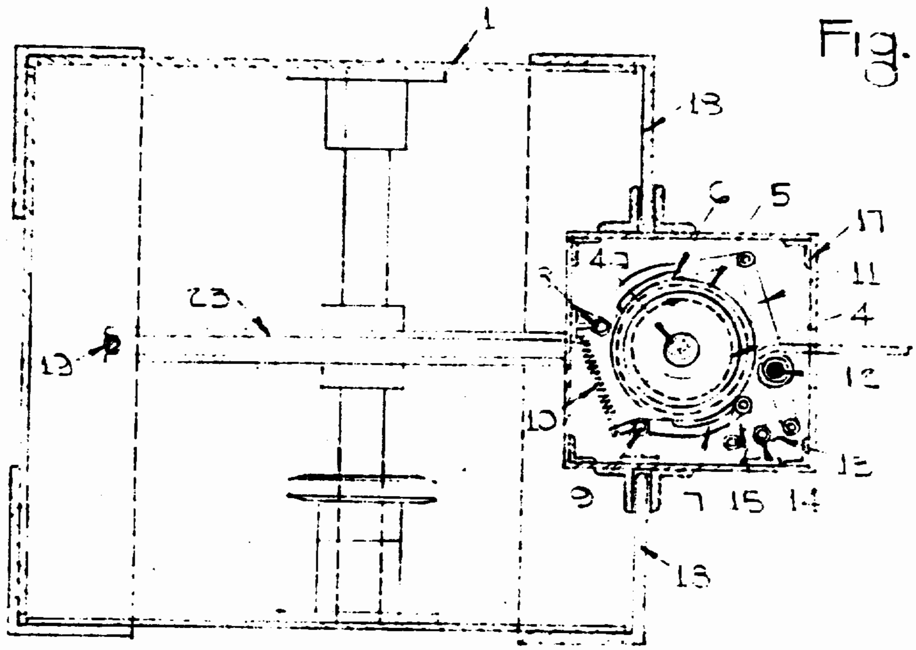


Fig. 5

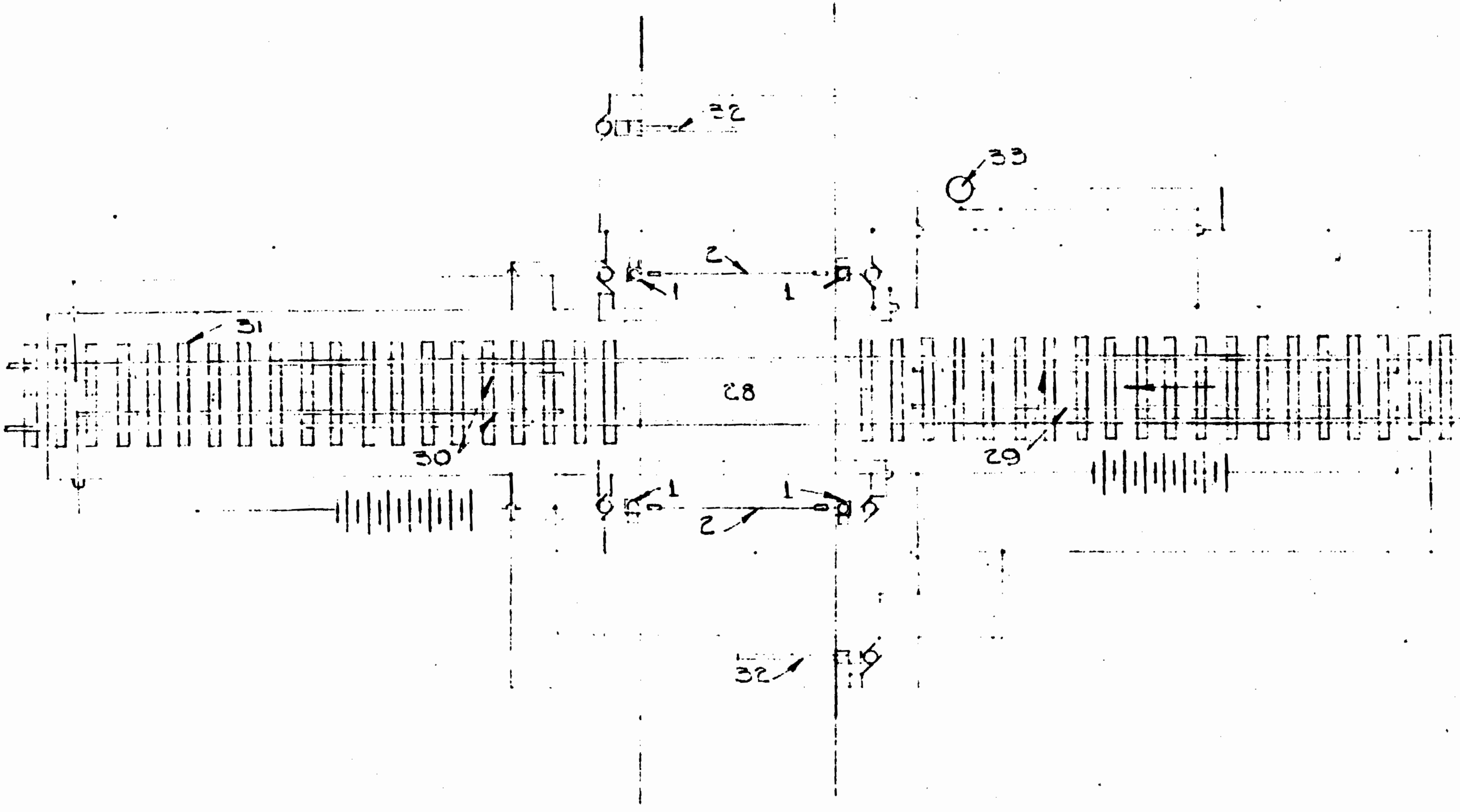


Fig. 7

produced by means of two air propellers or fans 14, located at the outer end of the arm and mounted to rotate about an axis substantially perpendicular to it. These two propellers, one above and one below the arm, are actuated by means of a motor 15 mounted on the arm and operatively connected with the propeller shafts. This motor is controlled by the operator on the car by means of the electrical conductors 15a. When the propellers are operated, they act upon the air and move the arm about its axis of rotation.

The Aeroscope is provided with an auxiliary actuating mechanism to be used in case the propellers for any reason failed to act. The mechanism consists of a gear wheel 19 connected with the arm and operated by means of a motor 20 mounted on the tower. This motor is controlled by the operator on the car by means of the electrical conductors 20a.

The car is pivotally suspended from the side pieces 16 of the arm by means of a shaft 17 movably mounted upon them as shown in Fig. 3. This car is also rotated about its axis by means of a motor 18 mounted upon it. This motor has a pinion 21 which engages a gear 22 connected with a supporting piece 23 fixed against rotation but upon which the car is rotatably carried.

Two arms 24 are provided to keep the car always in a vertical position. These arms are pivotally connected at one end to the fixed parts 25 attached to the support and at the other end to the car through the shaft 17. As the arm 2 turns over, the parts 25 and 26 are maintained in parallel relation, the arms 24 always remaining parallel to the axis of the arm 2, thereby maintaining the car in an upright position at all times.

The brake shoe is controlled by a magnet or solenoid 9a, which in turn is controlled from the car by means of conductors 9b. When the magnet is energized, the brake will be set and when deenergized, it will be released by its own weight.

The car is provided with a series of weights 27 which may be removed or attached for the purpose of balancing it as the number of passengers varies. These weights are attached by being slid into a compartment at the bottom of the car, as shown in Fig. 4. They are slotted to pass the holding piece 28 as shown by the dotted lines in Fig. 5. When inserted in this manner, the weights are provided with eyes for handling them. These balancing weights may be used alone to balance the car, or the counterweight may be used alone, or the two may be used conjointly.

For the purpose of balancing the arm before it is set in motion, there is a holding piece 28, which is fastened to a fixed part 29 below the car and which extends through a slot 30 in the bottom. It is provided with projections 31 and 32 located on opposite sides at the bottom. The piece is rotatable so that it may be moved to permit the projections to pass through the slot, and may then be given a half turn so that the car will be locked against movement up and down except a small movement between the projections. When the car is down, the holding piece is placed in position as shown in Fig. 4, and when the number of passengers who are to be carried have entered the car, the operator balances the arm by means of the counterweight or the weights until the bottom of the car is at a point between the projections. The holding piece is then turned so that the projections will pass through the slot and the car is then started. The projection acts as a safety device and prevents the movement of the arm while it is being balanced. If some safety device is not used, the operator might move the counterweight too far out and thus cause the arm to be moved at too great a speed, and before he is ready to make the trip.

The motor which rotates the tower may be controlled by the operator in the car by means of the electrical conductors 5a. These various conductors for controlling the several motors are flexible so as to permit the proper movement of the arm.

Joseph Strauss designed and built the Aeroscope for the 1915 Panama-Pacific International Exposition in San Francisco. Erection on the grounds commenced on October 25, 1914, and the first operation was on February 12, 1915, a few days before the opening of the Exposition.

The circular rack was 60 ft. in diameter and the steel supporting tower was 48 ft. high. The main arm was 200 ft. long from trunnions to car. The counterweight of steel and concrete weighed 380 tons and was located 38½ ft. behind the trunnions. The total weight of the Aeroscope was 700 tons.

The car was capable of carrying 120 passengers and a trip took about ten minutes. The Aeroscope was situated between a cyclorama and a roller coaster, both tall structures. When the arm had attained enough elevation to clear them, a train of gears began to rotate the tower on the circular rack so that the car described a huge helix as it rose in the air, turning the sides to all points of the compass and allowing the passengers to see in all directions about the region of San Francisco Bay. As the device stood at an elevation of 65 ft., the passengers were lift-to a total height of 330 ft. above sea level, where they had a grand view into seven counties and far out over the Pacific.[28]

28. Frank Morton Todd, The Story of the Exposition, (New York: G. P. Putnam's Sons, 1921), 151-152.

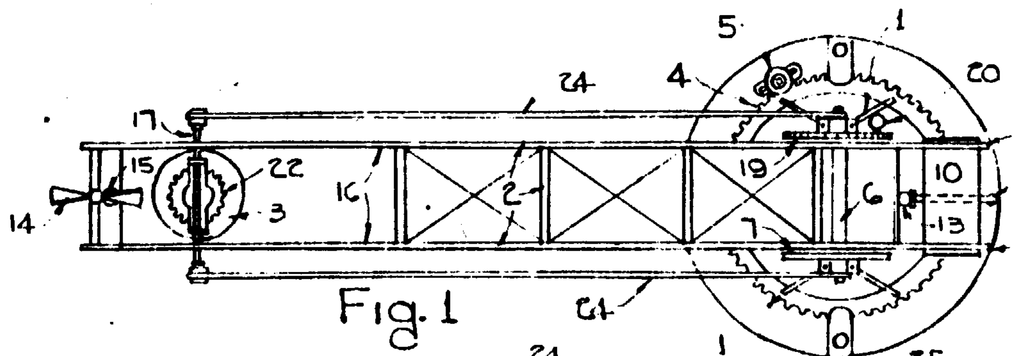


Fig. 1

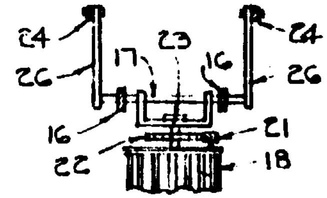


Fig. 3

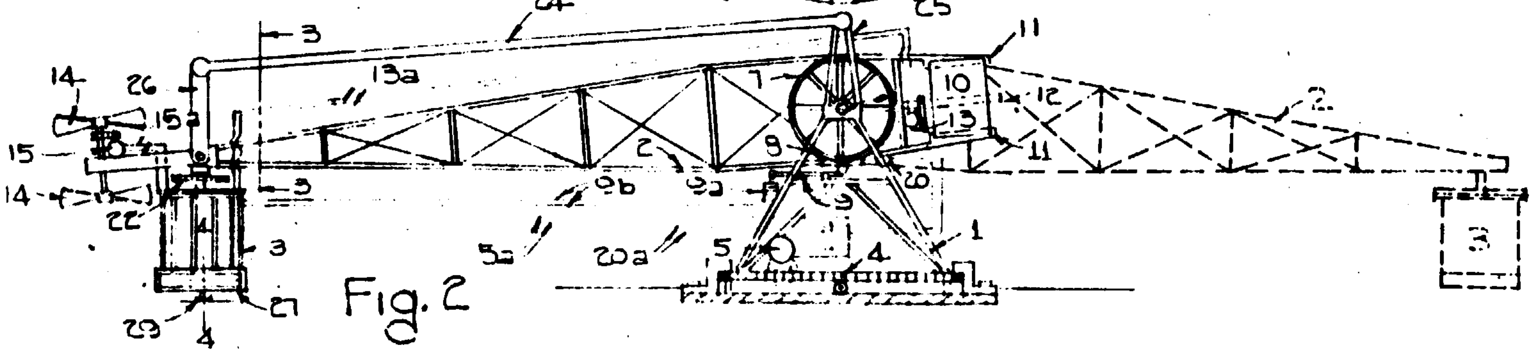


Fig. 2

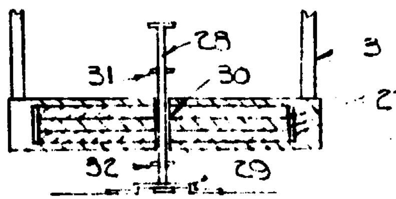


Fig. 4

Fig. 5

Aeroscope

REINFORCED CONCRETE GONDOLA CAR[29]

This type of freight car represented a new development in the use of concrete. It was designed by Joseph Strauss during World War I as a means of relieving the shortage of steel and the demand for cars. Plans were made for manufacturing various types of these cars on a commercial scale. The Concrete Car Co. was organized by Strauss, J. J. McCarthy and F. E. Sullivan of Chicago.

One of these cars was on exhibition in Chicago in 1919. It was built by the R. F. Conway Co. with many parts of the equipment contributed by the Illinois Central R. R. After 30 days service on that line it was turned over to the United States Railroad Administration.

The car body was 41 ft. long, 9 ft. 8 in. wide and 4 ft. 8 in. deep. It was designed for 50 tons load capacity plus 10% for overload. Unit stress was taken at 16,000 lb. in steel and 1000 lb. in concrete. Impact was computed at 25%. As the thickness of the concrete was only 2⅜ in., it was decided to use the cement gun for making the sides and floor, the cross-bearers being poured in the usual way. Forms were placed on the outside of the frame and the concrete was shot from the interior. The density of the concrete applied in this way increased the weight, but it was estimated that cars of this size and design could be made weighing 23 to 24 tons. A new light-weight aggregate, known as haydite and invented by Stephen J. Hayde, of Kansas City, was used. This made concrete weighing only 104 lb. per

29. U. S. Patent No. 1,299,411, (April 1, 1919).

cubic ft., with a compressive strength of 4450 lb. in 28-day tests.[30]

Referring to the accompanying drawings:

Fig. 1 is a side elevation of one form of this car.

Fig. 2 is a sectional view taken on line 2-2 of Fig. 1.

Fig. 3 is an enlarged view taken on line 3-3 of Fig. 1, with the steel reinforcement in full lines, and the concrete portion of the car body in dotted lines.

Fig. 4 is a vertical section through one wall of the car and a portion of the bottom showing a modified construction.

Fig. 5 is a sectional view taken on line 5-5 of Fig. 6.

Fig. 6 is a sectional view taken on line 6-6 of Fig. 5.

Fig. 7 is a plan view, with parts omitted, of a portion of the bottom steel reinforcing framework.

Fig. 8 is an enlarged sectional view with parts omitted taken on line 8-8 of Fig. 1.

Fig. 9 is an enlarged sectional view, with parts omitted, taken on line 9-9 of Fig. 1.

Fig. 10 is an enlarged sectional view, with parts omitted, taken on line 10-10 of Fig. 1.

Fig. 11 is a view showing in elevation one of the reinforcement engaging projections shown in plan in Fig. 7.

Fig. 12 is a sectional view through a portion of the bottom and wall of a car showing a modified construction.

In Fig. 1 and associated figures is shown this car in which the body, bottom, side walls and end walls are all composed of

30. Engineering News-Record, (March 20, 1919).

concrete reinforced with steel. Extending longitudinally along the bottom of the car is a steel member 1 in the form of a beam or girder. The draw bars 2 are connected to this longitudinal member.

At the bottom of the car body opposite the floor is a steel frame 3 which extends all the way around the body forming a rectangle. In each end of the car, at the point where it is connected with the truck, is a transverse steel member 4 which is made up of two sections, of which the inner ends are connected to the longitudinal member.

Angle members 5 are connected at one end with the longitudinal member and at the other end with the transverse member by means of gusset plates 6. A steel piece 8 connects the two sections of the transverse member and extends across the top of the longitudinal member. Reinforcing bars 9 are embedded in the side wall 10 of the car and are connected with the gusset plates and transverse members, as shown in Figs. 7 and 10.

At the top of the car is a rectangular steel frame 11 which extends along both sides and both ends. It is connected with the bottom frame by the steel members 12, thus composing a complete box steel frame which forms the corners and the top portions of the walls of the car. The reinforcing bars extend through the top member of the frame as shown in Fig. 10. Steel plates connect the side members of the bottom frame with the ends of the transverse members as shown in Fig. 11. The trucks 13a are connected with the longitudinal and transverse members by the king pins 14.

The side walls are provided with reinforced ribs 15 at the point where the transverse member is located. These walls are also provided with reinforced ribs 16 at intervals. The bottom is provided with ribs 17, integral with the floor, the inner ends abutting the longitudinal member. The floor and walls of the car are provided with steel reinforcing bars which interlock. One method of inserting these members is shown in Figs. 5 and 6. In these figures there are a series of floor reinforcing bars 18 which are bent up at the ends as shown in Fig. 5 and connect with the longitudinal wall reinforcing bars 19. The walls are also provided with the diagonal reinforcing bars 20 and 21, which are connected with the metal frames at the top and bottom of the car. Note that these bars are placed more closely together at the points where the greater stresses and strains are located, that is, near the ends of the car where the car body is connected with the trucks.

The concrete ribs at the bottom of the car are provided with the inclined reinforcing bars 22, which are in the form of a truss, the outer ends of which are connected with the plates 23. These plates are connected with the bottom frame and extend along the ends of the ribs. Steel corner pieces 24 are provided at the bottom of these ribs.

The inclined reinforcing bars in the form of a truss extend entirely across the car bottom as shown in Fig. 2, passing above the longitudinal member, and are similarly connected at their opposite ends. These ribs are also provided with a similar steel reinforcing bar 22a, which extends below the longitudinal member. Reinforcing bars 26 connect the corner pieces 24 and the frames. Along the walls at other places than where ribs occur, reinforcing bars 27 are provided which connect the frames as shown in Fig. 8. The reinforcing bars 9, 26 and 27 are made adjustable by means of nuts and screw threads, as shown in Figs. 8, 9 and 10.

The reinforcing bars 27, for example, are connected to the eyebolts 28 which pass through the bottom frame and are held in place by the nuts 29. These bars are held to the top by means of the heads 30.

At the ends of the car body the reinforcing bars 30 extend across the end and part way along the sides as shown in Fig. 3. Also, the bars 31 extend part way across the end and part way along the sides. These bars are preferably in the same horizontal plane although this relation may be changed if desired.

The inclined reinforcing bars 32 are also provided at the ends of the car body. They are connected with the floor and extend along the sides in the inclined position and then run across the ends through the ribs 33 as shown in Figs. 2 and 5.

The transverse steel members act as bolsters and reinforcement engaging projections 34 are attached to these members and also to the central longitudinal member or sill. One of these projections is shown in Fig. 11 and consists of angle pieces, one angle of which is connected to the member with which the device is associated, the other angle projecting from it and provided with one or more grooves 34a to receive the central reinforcing member or members.

The longitudinal member is of box girder construction comprising two side members connected together and provided with a space between them. The connecting pieces 1a are located at intervals along these members. The draw bar at each end passes into this space between opposed inwardly projecting members 35 as shown in Fig. 7.

In Fig. 4 is shown a modified construction in which the reinforcement consists of an expanded steel or woven steel section 10a. In this construction is provided a concrete car body having a concrete floor with steel reinforcement and steel members or frame pieces connected with the body, the floor reinforcement interlocking with the frame pieces. The longitudinal member acts as a beam to carry part of the load of the body and the side walls, which are integral with the concrete floor, have exposed top and bottom steel members, the reinforcement in the side walls being connected with these members. The side walls act as girders to carry a portion of the load of the car body, the entire structure forming as it were a unitary car body. The parts are also arranged to properly take care of the stresses and strains due to the draw bar pull both longitudinal and lateral and will also carry the stresses and strains due to the connection of the body with the trucks.

Note also that the concrete ribs at the bottom of the car and the steel transverse members have their inner ends abutting the central steel member. In Fig. 12 is shown a modified construction in which the longitudinal member is provided at the top with the pieces 36, which are shown as Z bars and which are connected at the top by the plate 37. The floor abuts these Z bars, and there are reinforcing members 38 which are connected at their inner ends with the Z bars or central longitudinal member, their outer ends being bent up into the walls. There are also the looped or truss reinforcing members 39, which extend all the way across and preferably pass above the central longitudinal member and through the Z bars. There are also the reinforcing members 40, which connect with the opposite sides of the frame, and which extend entirely across the bottom. The members 38 are located at intervals all along the bottom of the car while the members 39 and 40 are only at the points where the floor ribs or beams 17 are located. The members 38 may also be used in the construction shown in Figs. 1 and 8.

Fig. 9 shows a construction where the reinforcing members in the ribs are arranged somewhat differently from that shown in Fig. 2. In this construction member 22 is arranged as shown in Fig. 2, but the other member 22b instead of crossing the member 22, is attached to the parts 23 and 24 in the same horizontal plane.

Reinforced Concrete Gondola Car

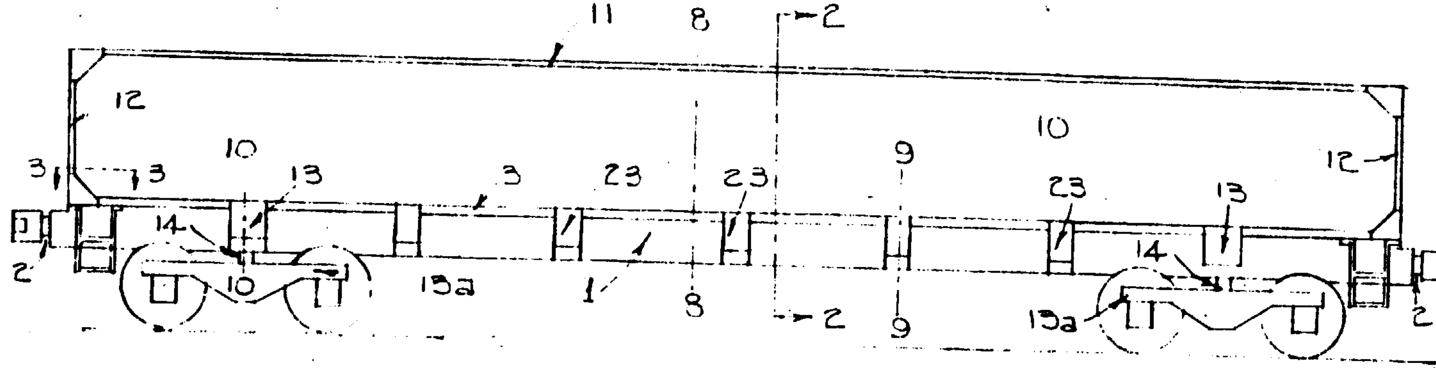


Fig. 1

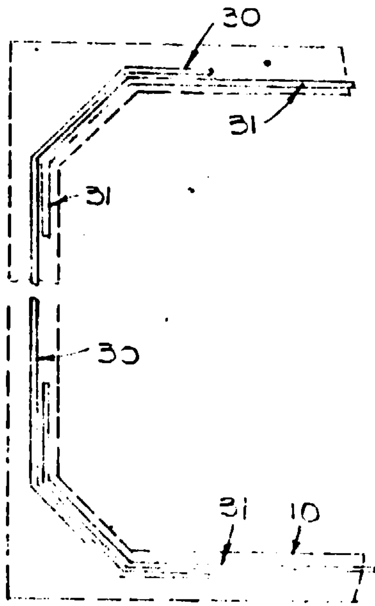


Fig. 3

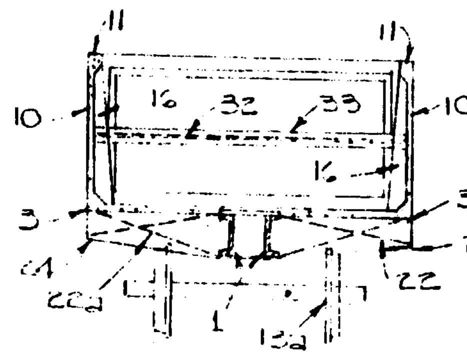


Fig. 2

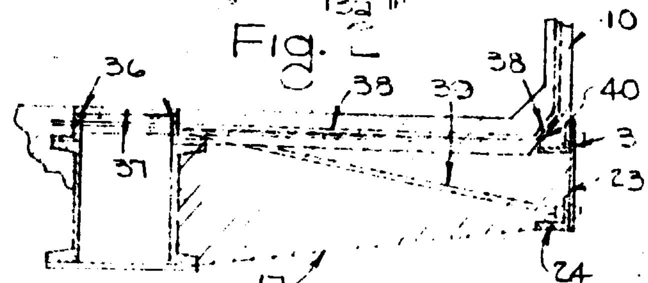


Fig. 12

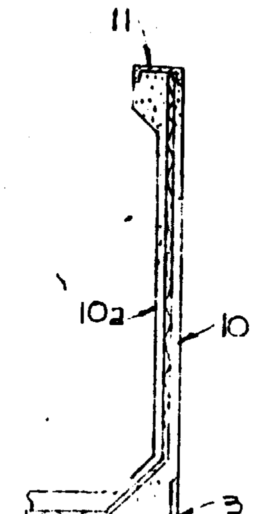


Fig. 4

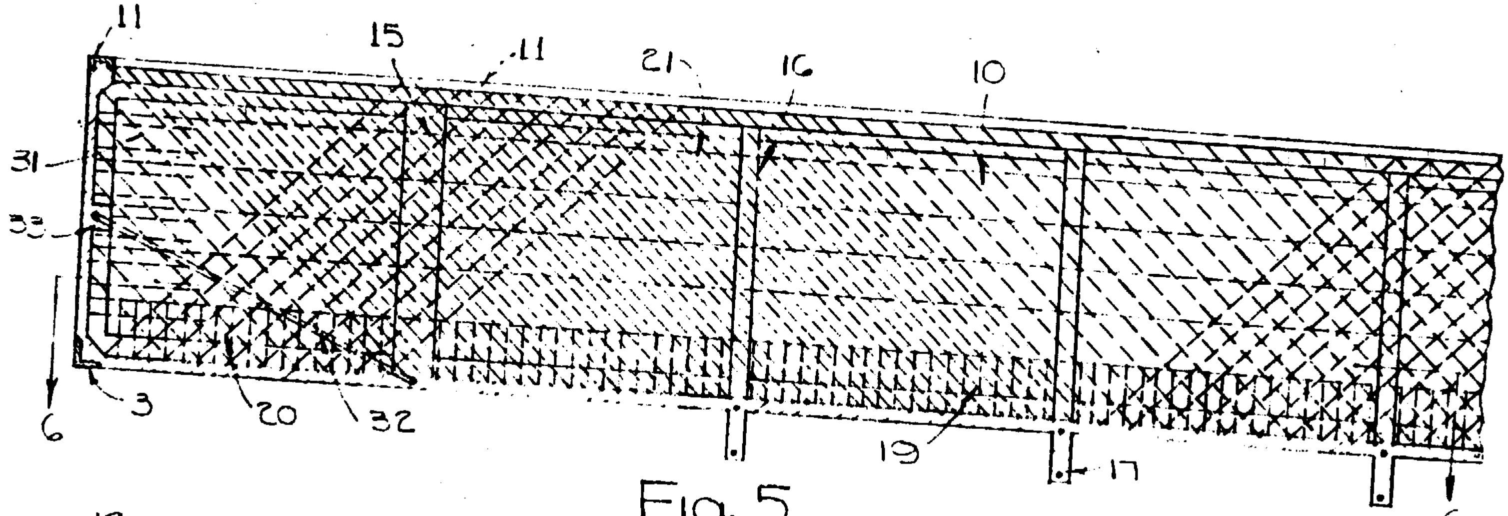


Fig. 5

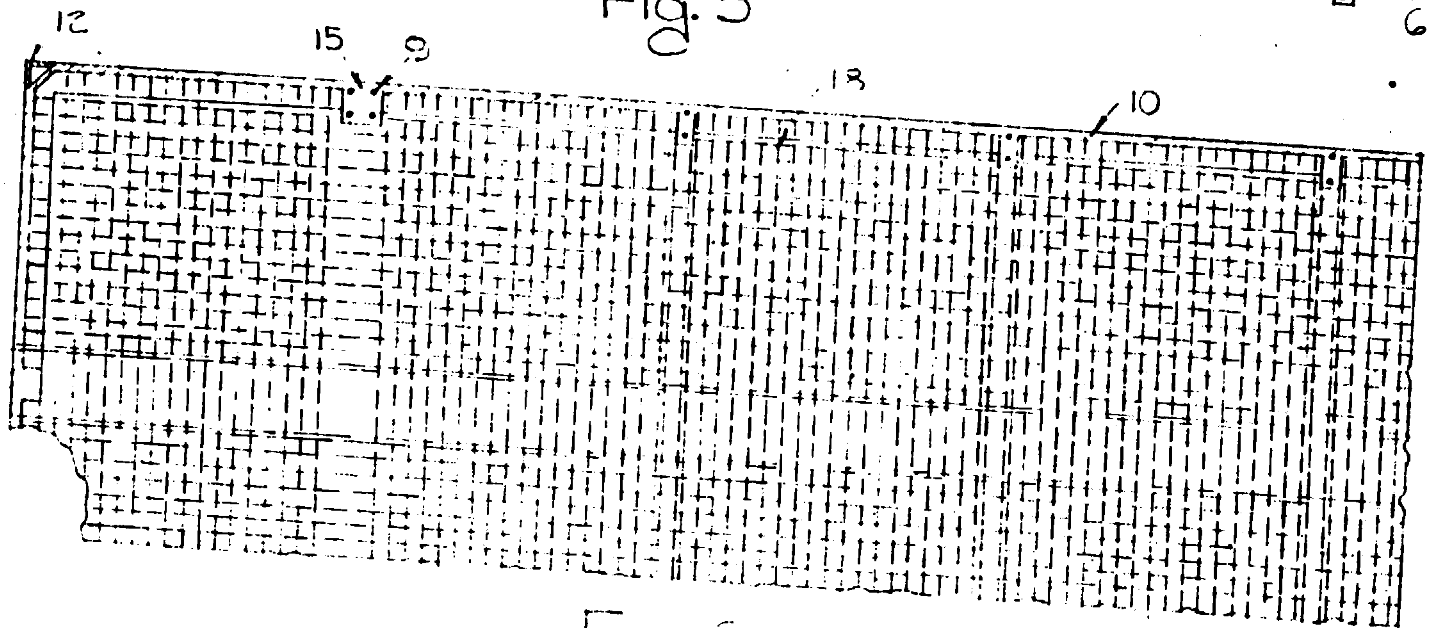
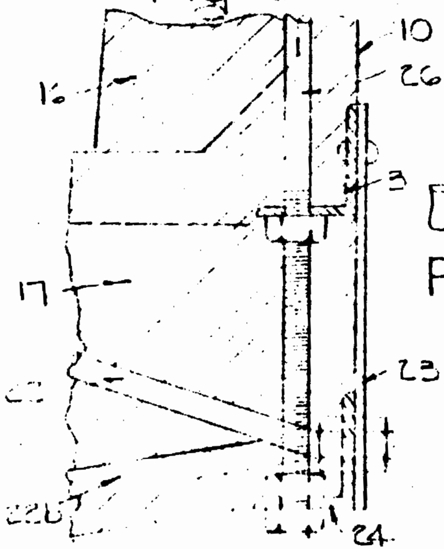


Fig. 6

Fig. 9



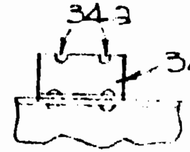


Fig. 11

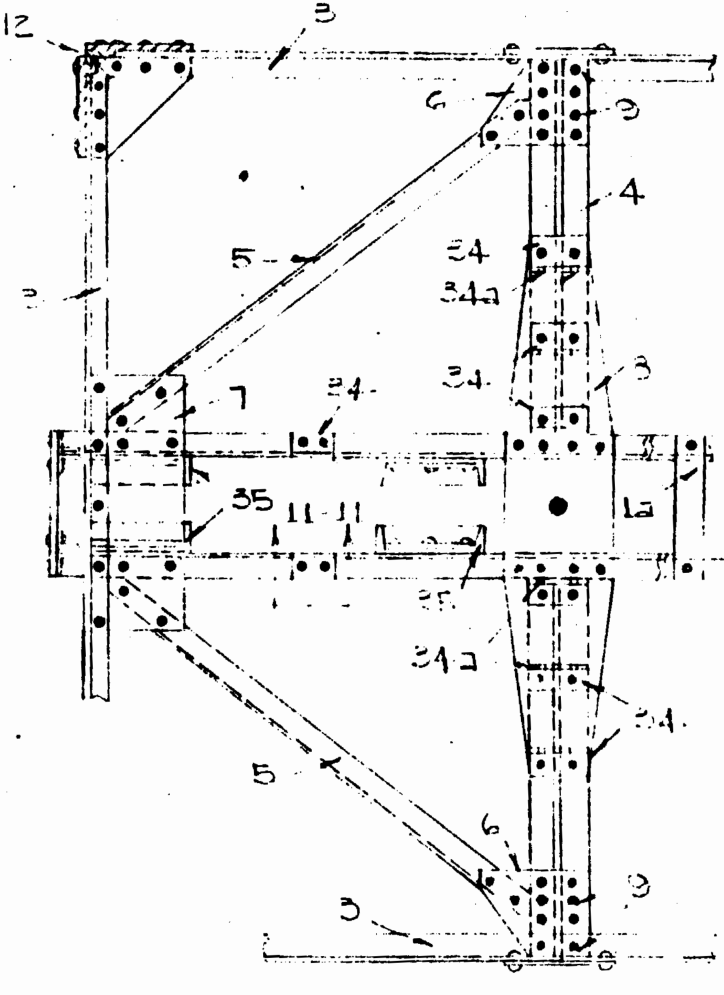


Fig. 7

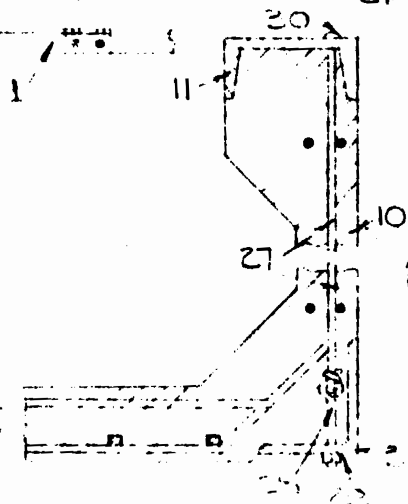


Fig. 8

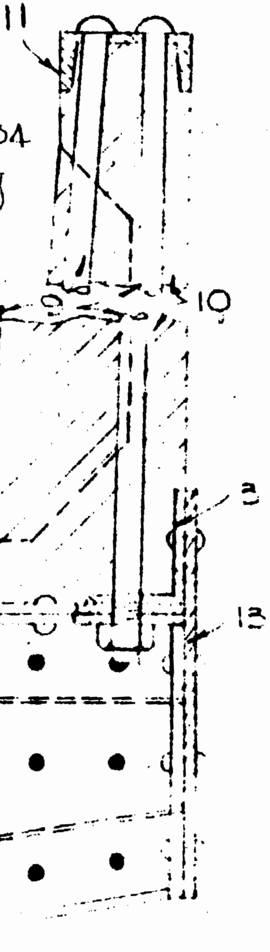


Fig. 10

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MILITARY RECONNOITERING APPARATUS[31]

Joseph Strauss designed a number of portable searchlight outfits which were used by the United States and Russia during World War I. These outfits could be easily and quickly transported to the point of use and moved to their operative positions.

Referring to the accompanying drawings:

Fig. 1 is a view showing one form of this apparatus.

Fig. 2 is an enlarged view showing in detail a portion of the device shown in Fig. 1, consisting of the observation tower located on the transporting truck.

Fig. 3 is a view in diagrammatic form, showing the observation tower of Fig. 2, demounted from the truck.

Fig. 4 is a sectional view taken on line 4-4 of Fig. 3.

Fig. 5 is a sectional view taken on line 5-5 of Fig. 2.

Fig. 6 is a view with parts broken away, showing the cable connections between the two sections of the tower and between the platform and the arms at the bottom of the tower.

Fig. 7 is a view showing one of each of these cables as seen when the tower is in a position at right angles to that shown in Fig. 6.

Fig. 8 is a view in part section showing a form of power device for controlling the observation tower.

In Fig. 1 is shown a truck 1, driven by an internal combustion engine 2. Mounted upon the truck is a demountable frame 3 carrying an extensible tower 4 pivoted to it. The folding

31. U. S. Patent No. 1,506,277, (Aug. 26, 1924).

legs or supports 5 are moved to their operative positions, as shown in Fig. 3, when the tower is used separate from the truck. When in this position, the supports are held by the braces 6. The wheels 6a permit the frame to be used as a trailer which can be pulled along by the truck.

The tower is pivoted at 7 to a portion of the frame and is made up of two sections, 8 and 9, slidably connected together. These two sections are provided at their corners with the angle pieces 10 and 11, which slide one upon the other when the two sections of the tower are moved relatively.

Pivotally connected with the upper end of the tower at 13, is a platform. This platform is kept in a horizontal position during all the various positions of the tower. This result is secured by means of the arms 14 connected with the platform at the pivot point or trunnion, and the arms 15 connected with the frame 3. There are two sets of arms, one on each side of the tower. These arms are connected together by cables, which automatically adjust themselves when the tower is lengthened or shortened, by moving the two members relatively, as will be more fully explained. A searchlight 16 is connected with the platform so as to be held in its proper position throughout all the various positions of the tower.

A mechanism is provided for moving the tower from its lowered position to its raised position and back again to its lowered position. The ends of the cable 18 at each side of the tower are connected to the tower at the points 19. The cable passes around pulleys 20, 21 and 22. The pulley 20 is connected with an upright 23 attached to the frame 3. By moving these cables, the tower may be moved to and from its raised position. The cables are moved by a hydraulic mechanism consisting of one or more cylinders 23a mounted on the platform 3. These cylinders are provided with pistons to which are connected rods. The piston rods, in turn, are connected with the cables 18. When the piston rods are moved into the cylinders, the cables will be rotated so as to lift the tower, and when the rods are moved outwardly, the cables will be rotated so as to lower the tower onto the frame 3, as shown in full lines in Fig. 2.

The liquid used in these cylinders is a non-congealing oil. It is forced into the cylinders to secure the desired pressure, by means of a pump 26 operated by a motor 27, the pump and motor being mounted on the frame 3. The pressure of this liquid then acts on the pistons in the cylinders so as to move them to lift the tower. The tower is lowered by permitting the liquid to be discharged from the cylinders, the weight of the tower causing it to move back to the position shown in full lines in Fig. 2.

The discharge of the liquid from the cylinders is controlled by a three-way valve so that the tower may be held in any desired position by closing the valve. When the pistons in the cylinders reach the limit of their movement they are stopped so as to hold the tower in its upright position.

The motor may be electric, securing its current through a connecting cable 28 wound upon a spring drum 29 on the truck frame 1, the current being supplied by a generator 30 mounted on the truck frame and run from the truck engine. By having the cable 28, the tower may be demounted from the truck and located at a distance from it while the generator on the truck is used to operate the electrical appliances on the tower, such as the motor and the searchlight and a signaling apparatus such as a wireless telegraph or other telegraphic or telephonic apparatus.

The tower may be raised and lowered by hand by means of a crank 31 connected with a shaft 32. This shaft is connected by gears 33 with a drum 34 about which passes a cable 35. The cable runs about pulleys 36 and is connected with the cables 18 so as to move them when the crank is rotated. When the crank is used, the cylinders are arranged so that the pressure of the liquid will not interfere with the hand-controlled apparatus. The tower may be held in any desired position by the pawl and ratchet construction.

A hydraulic mechanism moves the two sections of the tower with relation to each other to extend or collapse the sections. The cylinder 37 is connected with the lower tower section 8 so as to move with it. This cylinder contains a piston and a piston rod which is connected with the section 9 of the tower by means of a cross-piece 39. Liquid is forced into this cylinder 37 by the pump 26. When liquid is forced into the cylinder back of the piston, the piston and rod will be moved outwardly so as to move the outer section of the tower to its extended position. When the piston reaches the limit of its travel, the tower is in its fully extended position and is stopped in this position.

The platform 12 is kept in a horizontal position during all the various positions of the tower from its down position to its up position by a device arranged so as to automatically adjust itself when the tower is lengthened and shortened by moving the two sections relatively. On each side of the tower (see Figs. 6

and 7) is a cable 40, one end of which is fastened to the arm 15. This cable then passes around a pulley 41 mounted on a shaft 42 on the lower section 8 of the tower after which it passes downwardly and over a pulley 43 connected with the moving block 44. The cable then passes upwardly and is connected with the arm 14, engaging the pulley 45.

A second cable 46 is connected at 47 with the lower section 8 of the tower and then passes up over a pulley 47a on the movable block 44, and then downwardly and about the pulley 48 mounted on the lower section of the tower. The pulley 48 and the connection 47 are on the line connecting the centers of the two arms 15 on opposite sides of the tower. The cable 46 then passes over a pulley 49 connected with the lower section 8 of the tower, and is then attached at 50 to the upper section 9 of the tower.

By means of this construction, when the upper section of the tower is moved upwardly, the blocks 44 move upwardly half of this distance and the cable 40 is lengthened half of this distance by the shortening of the distance between the blocks 44 and the pulleys 41, and the reverse condition is true when the upper section is lowered. Thus, the platform 12 is maintained in its horizontal position and the device automatically adjusts itself to the shortening and lengthening of the tower.

In Fig. 1 is shown the tower and its frame mounted upon the truck 1, and a second frame 51 acting as a trailer and connected with the truck by a piece 52. This second frame is provided with wheels 53 which are connected to folding legs or supports 54 provided with braces 55. This frame may be mounted upon the truck like the frame 3 and the supports and braces folded for this purpose. This truck contains an apparatus 56 for sending and receiving messages such as wireless, or other telegraphic or telephonic equipment. This apparatus is shown folded in full lines and set up in dotted lines. It receives its current from the generator 30 on the truck 1.

In addition to using a searchlight 16 with the observation tower, a gun 57 may also be carried on it. This gun is shown in position connected with the tower, in Fig. 1, and the searchlight is shown removed and placed on the second frame 51.

When it is desired to use the entire apparatus, the observation tower is mounted upon the truck 1 and the second frame 51 is connected with it to act as a trailer, and the apparatus then quickly moved to the point of use. The signal receiving and sending apparatus may then be erected and the tower raised. The tower may be either raised while on the truck, or the tower and its frame demounted from the truck, as shown in Fig. 3. Observations may then be made and messages sent and received. The tower may be raised about its pivot any desired height and lengthened and shortened by moving the two sections relatively so as to raise the platform carrying the observer and the searchlight or gun to any desired height, and can be maintained at this height and observations taken or the gun used if necessary.

When it is desired to move to another point, the observation tower is loaded on the truck and the truck connected with the frame 51, and the apparatus easily and quickly transported to another point. When the tower is demounted, if the observers should be surprised by the enemy and there is not time to remount the tower, it can be dragged along behind as a trailer,

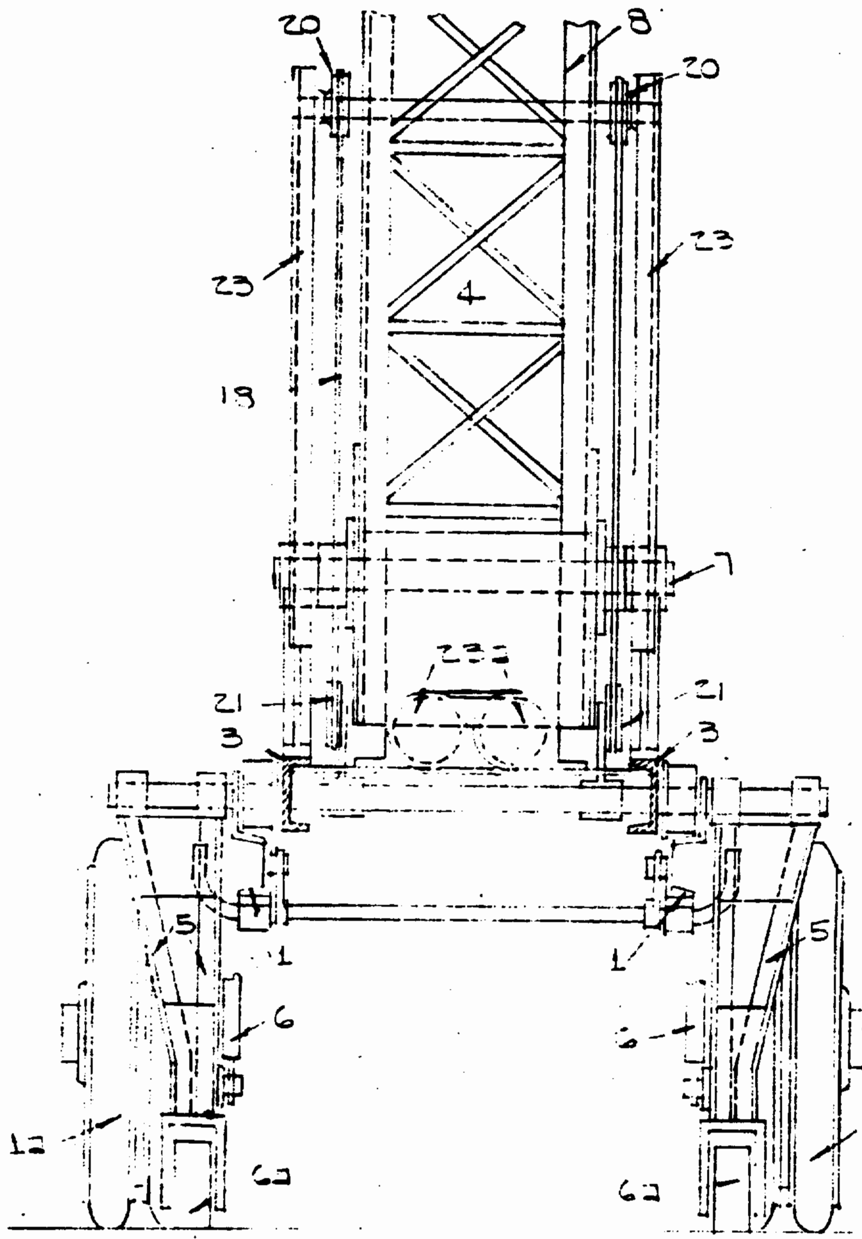

Fig. 4

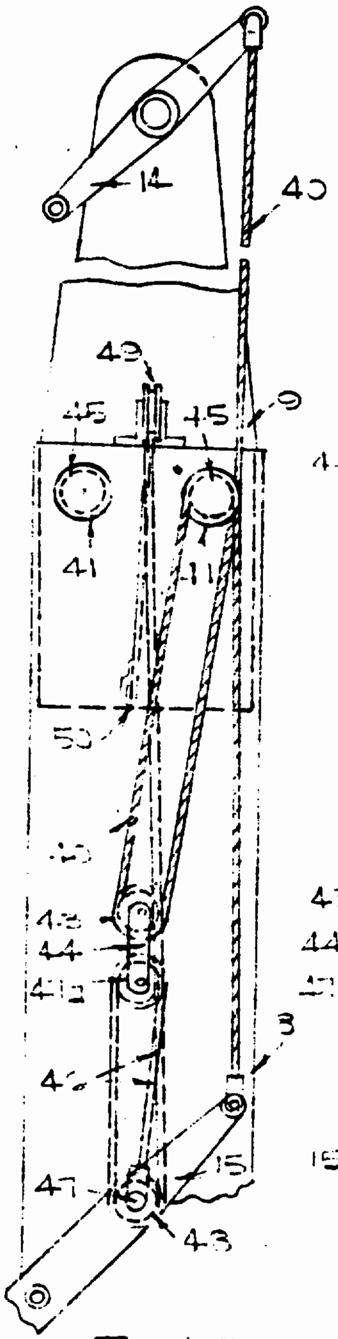
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Fig.7

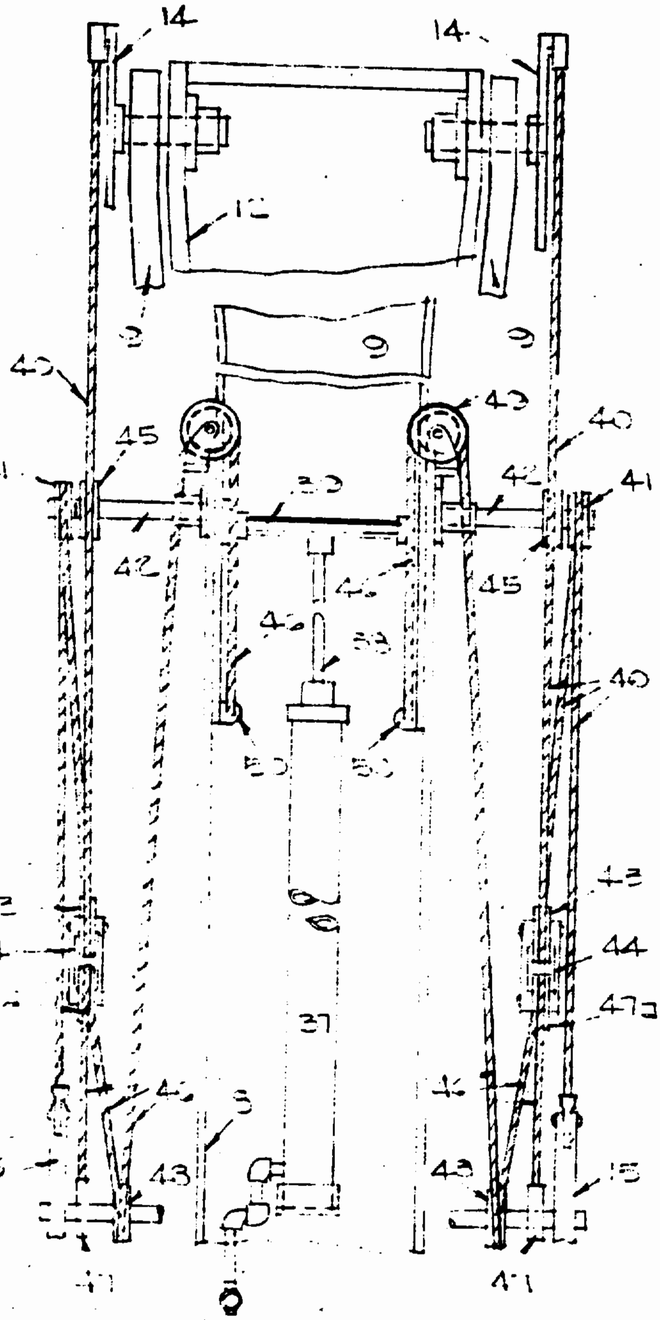
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Fig. 6

Military Reconnoitering Apparatus

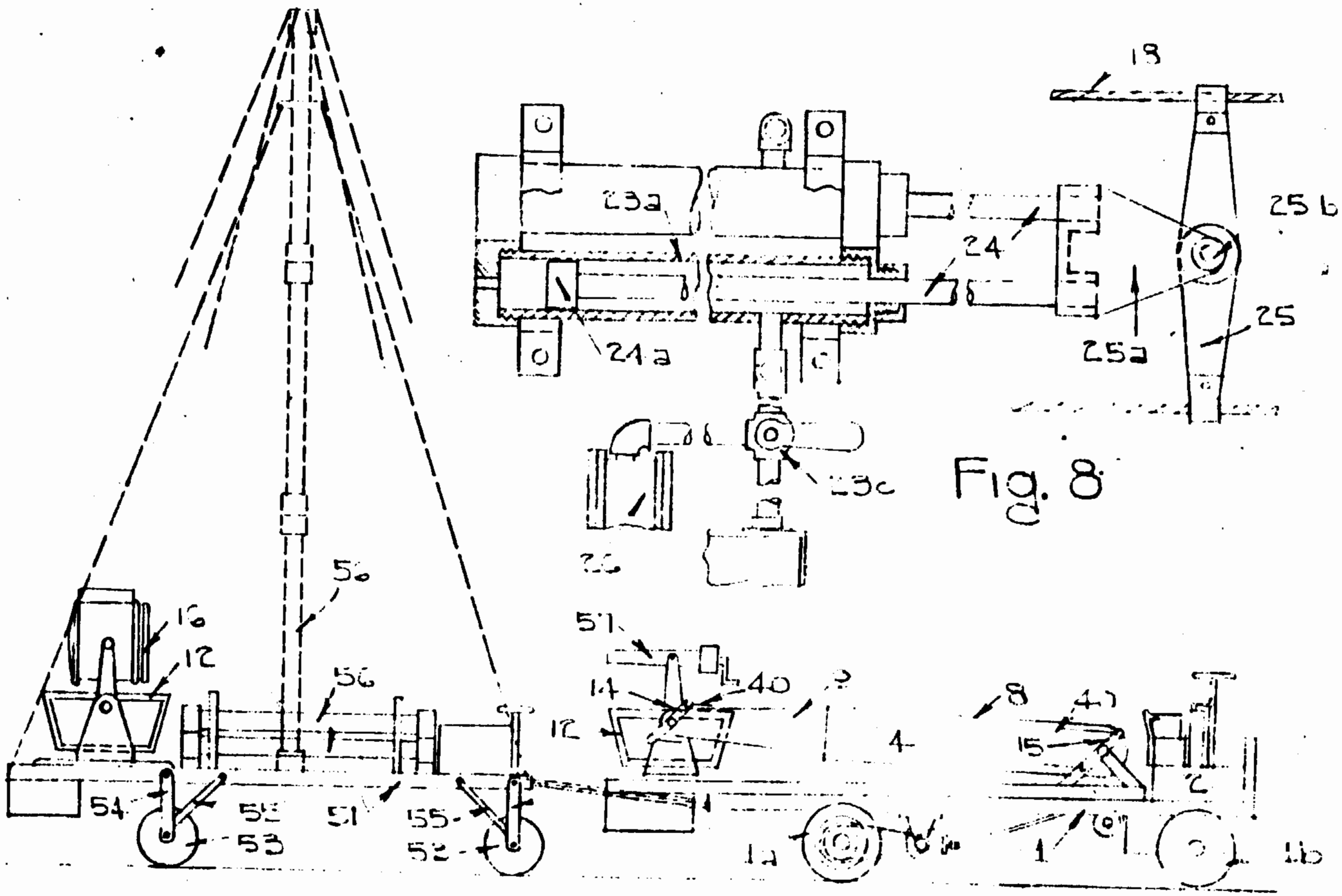

Fig. 8

Fig. 1

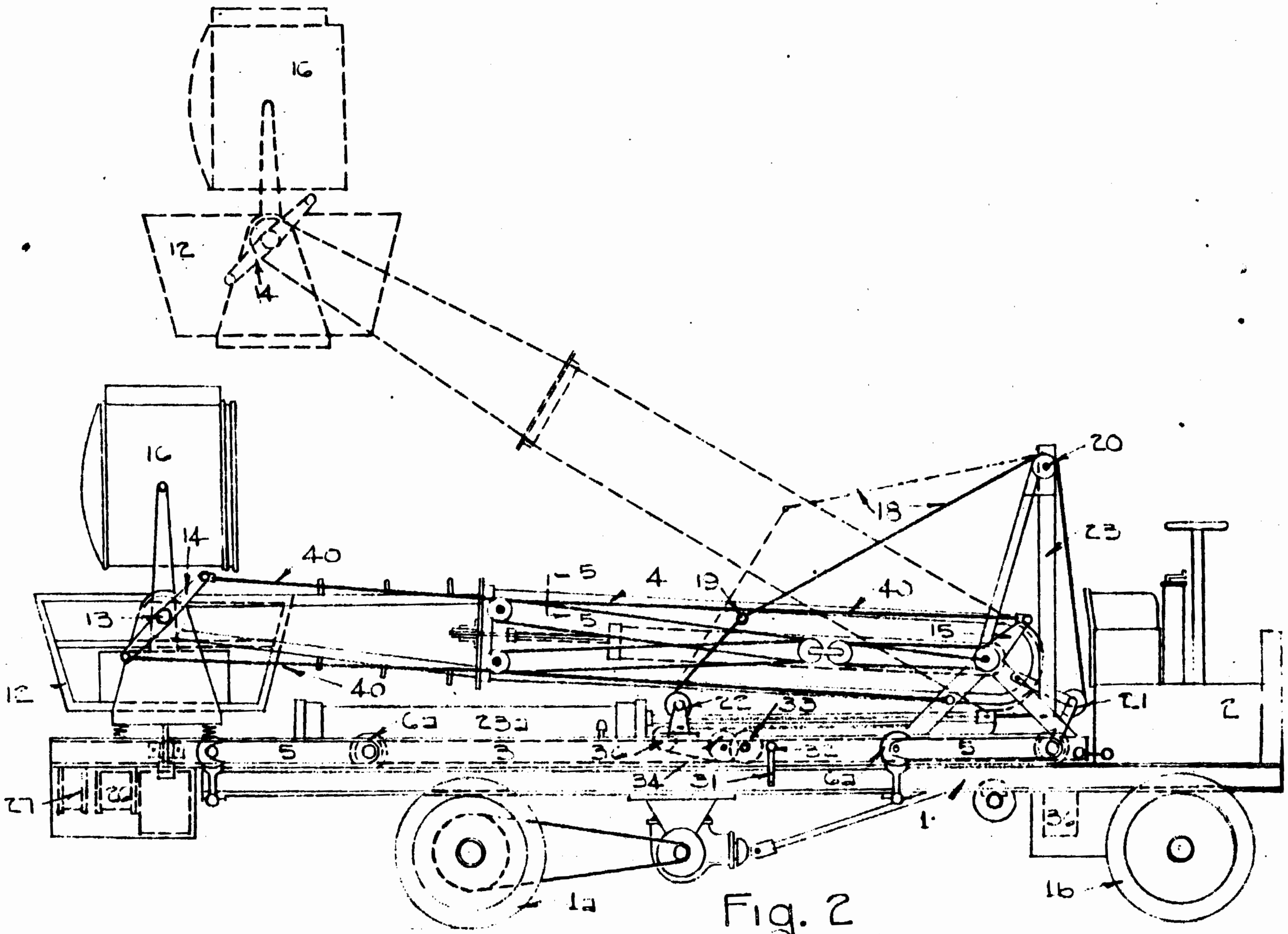
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Fig. 2

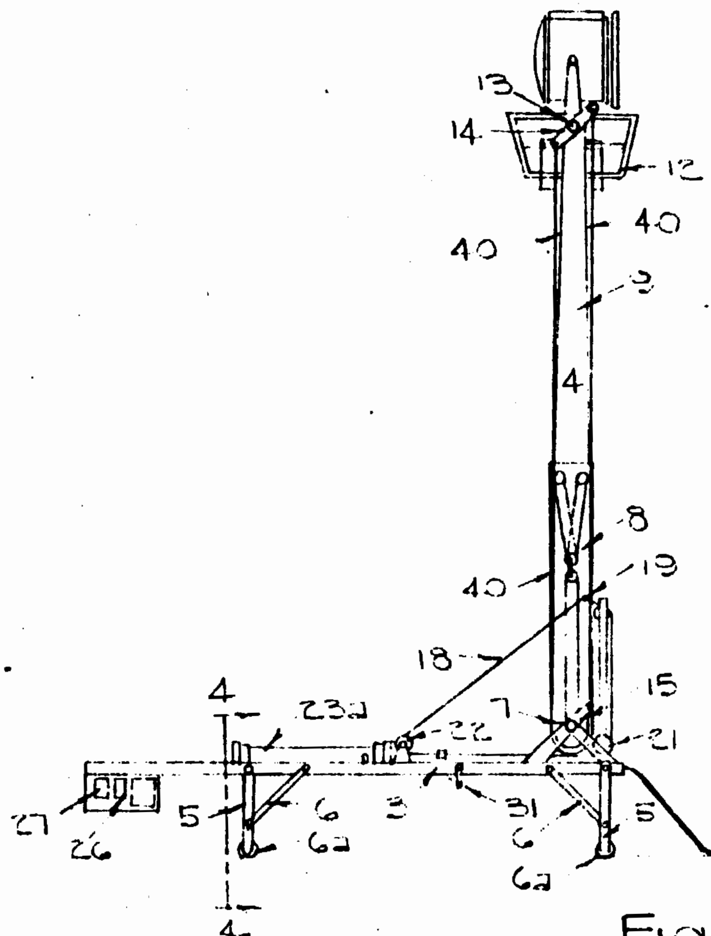
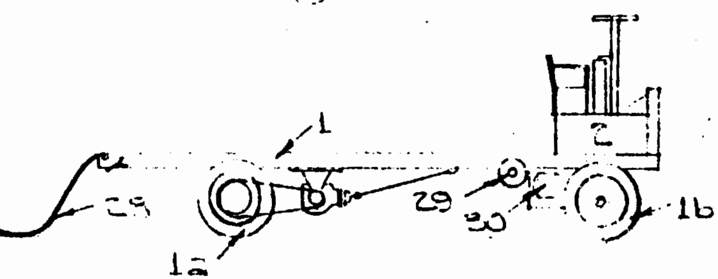
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Fig. 3

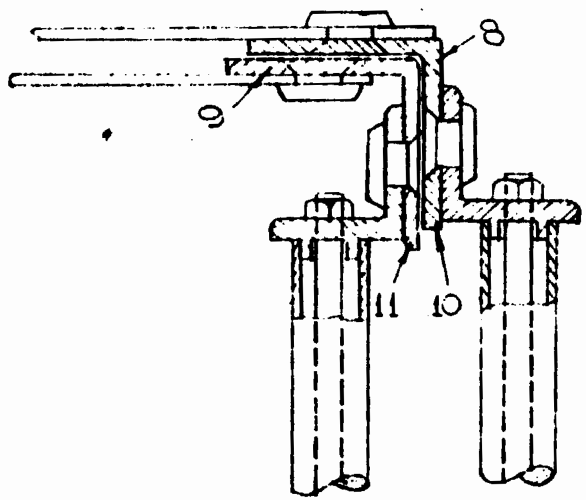
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Fig. 5

BASCULE DOOR HANGAR[32]

In 1920, Joseph Strauss designed and built this type of hangar for the United States Postal Aerial Service at Reno, Nevada. This unique hangar was also built for the Mexican Government at a later date.[33]

This invention provided a structure with a door that could be easily and quickly opened and closed so as to permit the aircraft which it housed to be easily inserted and removed.

Referring to the accompanying drawings:

Fig. 1 is a front view of the hangar.

Fig. 2 is a section through the door and the portions of the hangar adjacent to it.

Fig. 3 is a sectional view taken on line 3-3 of Fig. 2.

Fig. 4 is a view showing a modified construction.

The hangar is provided with a door 2 which may be opened and closed when the airplane is taken in or out. The door works on horizontal pivots and moves vertically to open and close it. As shown, the door is provided with a plurality of trusses 3, and is supported by pins 4 which are connected with the trusses and which also project through the supporting pieces 5 which are fastened to the supporting beams 6. Any desired number of trusses and supporting beams may be used. In the construction shown are illustrated four. The trusses are provided with projecting ends 7 which project beyond the pivotal points or pins. These ends project between the beams 6 as shown in Figs. 2 and 3. A counterweight 8 is attached to

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32. U. S. Patent No. 1,524,956, (Feb. 3, 1925).
33. The Record, (Dec., 1930), p. 315.

the projecting rear ends of the trusses by pins 19. This counterweight is also connected by links 10 with a fixed part of the structure by means of the pivots 11. The links are also pivoted to the counterweight by the pivots 12. The counterweight preferably counterbalances the door so that it is balanced in all its various positions and moves with the door. The position of the counterweight is shown in Fig. 2 in full lines when the door is opened, and in dotted lines when the door is closed.

A motor 13 is provided for opening and closing the door. This motor is connected with suitable gearing 14 and a shaft 15, having several pinions 16 which engage the racks 17 on the trusses. The door may also be operated by hand by means of a chain 18, passing over a wheel on the shaft 20. When this chain is pulled it rotates the shaft and the gear so as to open or close the door. There may be a chain at each side of the door if desired. The motor may be operated by means of the starter 21. There is a groove 22 in the floor 23 at a point just below the end of the door when it is closed. In this groove is a heating device, such as a steam pipe 24, so that any snow or ice that might otherwise obstruct the closing of the door will be melted so as to leave the space for the end of the door always clear.

The device is particularly adapted for large structures and by this means the door, regardless of its size and weight, can be easily handled because of its construction, its method of suspension and its counterweight arrangement. When the door is open it forms a canopy, thus increasing the space under which operators can work and still be under cover and protected.

In Fig. 4 is shown a construction where there are two doors or sections 27 and 28, one opening upward and the other opening downward. Both of these doors are counterbalanced as shown. The upper door is provided with pivots 27a and when opened acts as a canopy. The lower door when opened acts as the roadway or extended floor over which the airplane may be rolled into the hangar.

When two doors are used, that is where the device is divided into an upper and lower section, the upper section may be mounted and arranged as shown in Figs. 2 and 4. The lower section 28 has its pivots 29 held by supports 30, and a counterweight 31 is pivoted to the door and operates in a pit 32. These sections have extensions beyond the pivots and the counterweights are connected with these extensions. A space 33 is provided for the lower section when open so that it may act as a runway. The inner face 34 of this door is provided with a suitable covering so that it may act as a floor or runway when in its open position. It will be noted that when the door is opened all of the parts are beyond the limits of the clearance line of the openings to be closed, which is a line running crosswise of the opening at the upper and lower part, forming the limits vertically of the maximum opening.

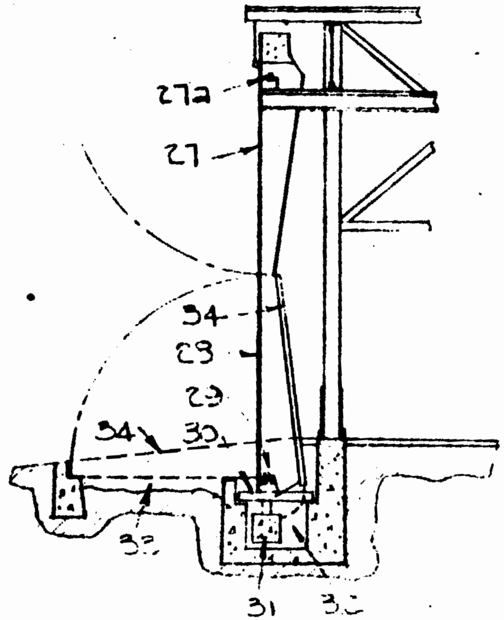

Fig. 4

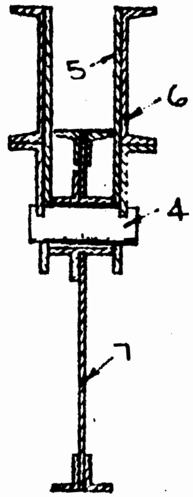

Fig. 3

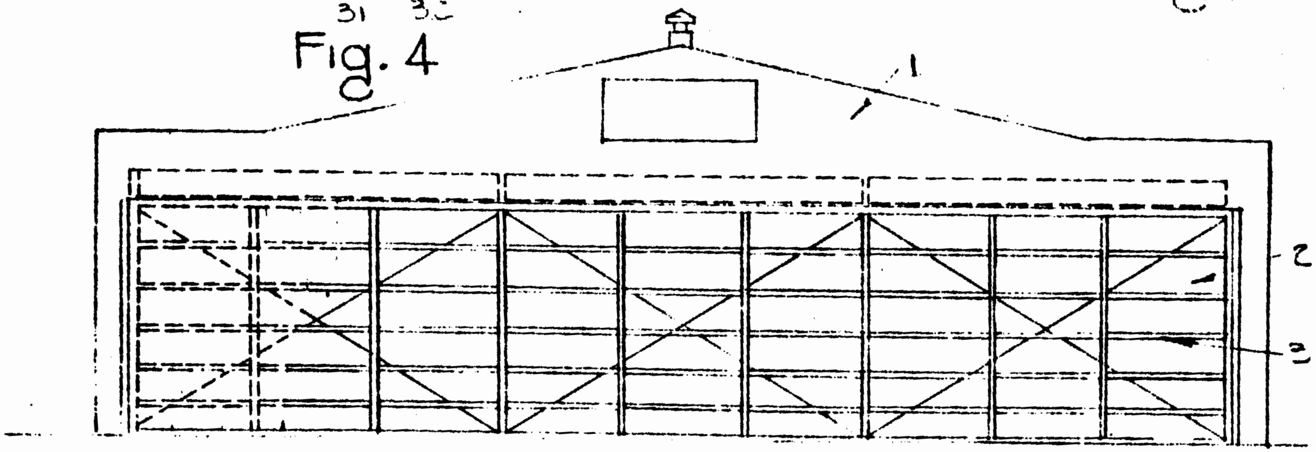

Fig. 1

Bascule Door Hangar

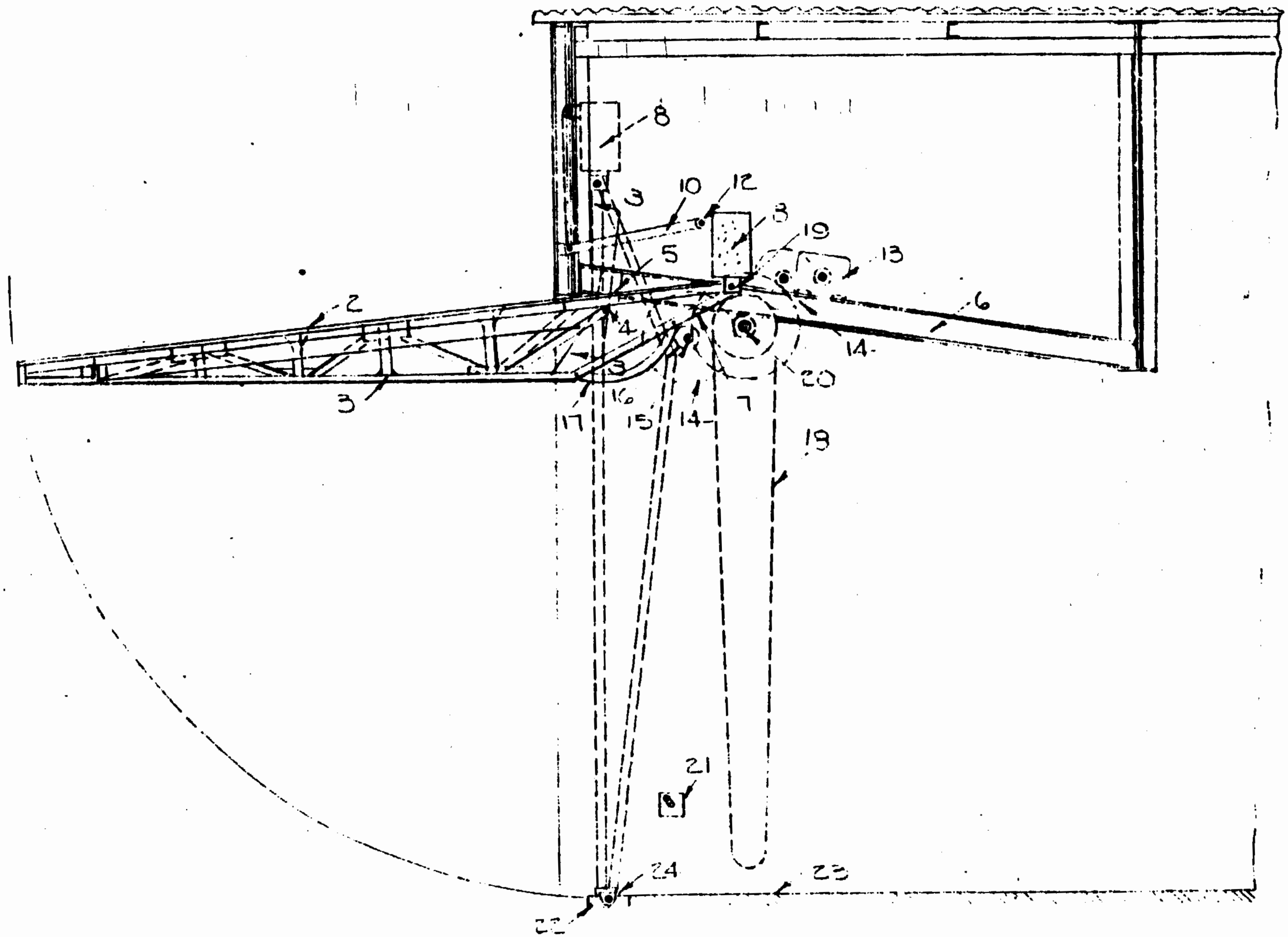

Fig. 2

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OBSERVATION TOWER[34]

Joseph Strauss designed and constructed a "disappearing" observation tower at Ft. Hancock, New York Harbor. It had an elevating arm which was raised and lowered like a bascule bridge, carrying a sixty-inch searchlight on its swinging platform.[35]

This tower was normally down and out of sight, but could be easily and quickly lifted to a substantially vertical position while observations were being made with the searchlight, and then returned to its concealed position.

This type of tower was mainly intended to be used in coast defenses. However, it could also be used as a mast for a vessel, being substantially flat on the deck when not in use and could be easily and quickly moved up to its operative position and then back to its safety position. It could also be located on a truck and used in the field, being moved from place to place with the tower being thrown up when it is desired to make observations.

Referring to the accompanying drawings:

Fig. 1 is a side elevation of the tower.

Fig. 2 is a view of the upper part of the tower as seen on line 2-2 of Fig. 1.

Fig. 3 is a side elevation in part section, of the upper end of the device shown in Fig. 2.

Fig. 4 is a detailed view showing the device for locking the platform to a fixed part when in its down position.

Fig. 5 is a plan view of the device shown in Fig. 4 with

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34. U. S. Patent No. 1,328,461, (Jan. 20, 1920).
35. *National Cyclopaedia*, p. 31.

parts broken away.

The base or support 1 has the movable tower arm mounted upon it. As shown in Fig. 1, this support consists of two elements, one at each side, and the tower arm is pivoted to these elements by means of trunnions 3. The tower arm is provided with some means for moving it. As shown, there is a rack 4 connected with the tower arm and this rack is engaged by a pinion 5 on a shaft containing the gear 6, which meshes with a pinion 6a on the shaft of a motor 7 located in the machinery house 7a.

At the other end of the tower arm is a platform 8 which is adapted to carry all observers and the observation appliances. The arm is provided with the two branches 9 and the platform is connected with these branches by the pins or trunnions 10. These pins are located at a point above the base of the platform and the space between the branches is free so as to permit the platform to rotate about the pins as the arm is lifted and lowered.

The platform is provided on opposite sides with inverted V-shaped hangars (see Figs. 1 and 3) which project upwardly to a point near the top of the railing, and the trunnions or pins are connected to these hangars. These hangars are provided with knee braces which are connected with them and extend diagonally downward to the base of the platform as shown in Fig. 2.

Some means is provided for keeping the platform in a horizontal position as the tower arm is raised and lowered. This result is secured by means of one or more controlling devices or arms 11, one at each side. These arms are pivotally connected at 12 with the carrying device and at 13 with the support, the connections at the two ends of the arms being at one side of the trunnions at the two ends of the tower arm. The arms are connected with the tower arm at one or more points by the links 14.

The tower arm has a tail end piece 16 which projects beyond the trunnions 3, and to which a counterweight 17 is pivotally connected by the trunnions 18. A link 19 also connects the counterweight with the support. This link keeps the counterweight in a horizontal position during all the various movements of the tower arm.

When a large searchlight is to be used, the platform is equipped with rails 20 and the searchlight 21 is placed upon a truck 22 having wheels 23, which run upon the rails 20 as shown in Fig. 3. By this means the searchlight can be kept in a shelter house 24 as shown in Fig. 1, the truck being run into this shelter house on the rails 25 which connect with the rails 20. When it is desired to use the searchlight the truck is run out on to the platform.

It is necessary to provide some means for locking the truck to the platform and for locking the platform to the ground when it is moved to its down position and the searchlight and truck removed. There is one locking device for performing both of these functions. It consists of a lever 26 which is connected with a shaft 27 upon which is mounted the truck-engaging parts 28. When the lever is in the position shown in Fig. 3, the engaging parts are moved up to clamp the axle of the truck and prevent its movement from the platform. When the truck is run on the platform it is moved until it engages the fixed stops 29 and it is held between them and the engaging parts. When the platform is in its down position, and it is desired to release the truck, the lever is moved so as to rock the shaft and move the engaging parts out of the way of the truck.

This same movement of the shaft moves the arm 30 to which is connected the locking pin 31. This locking pin passes through guiding devices 32 on the platform and also through a locking part 33 fastened to a fixed device, and the locking part 34 fastened to the platform. When the shaft is rocked to move the engaging parts out of the way of the truck, the locking pin is moved into locking position with the locking parts so as to hold the platform down after the truck and searchlight are removed. The removal of the truck and searchlight causes the arm to be unbalanced, and hence it is necessary to hold it down.

Observation Tower

Fig. 1

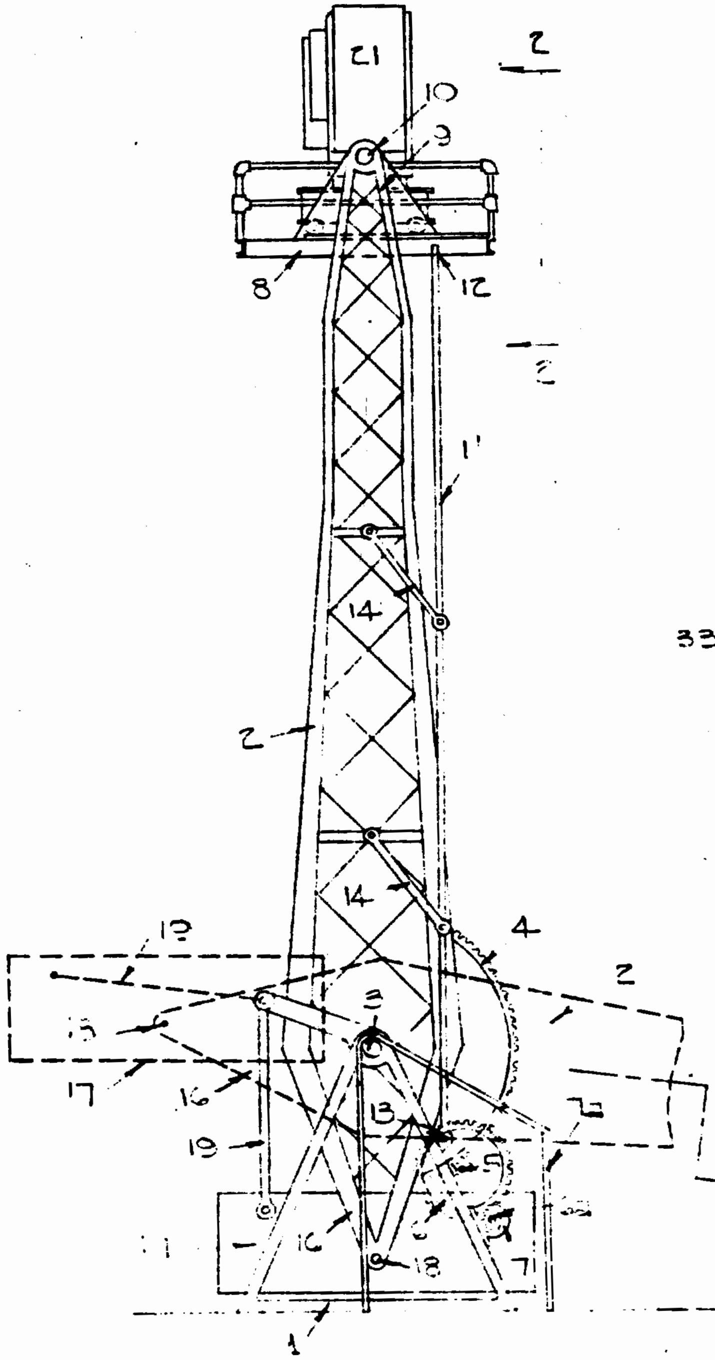
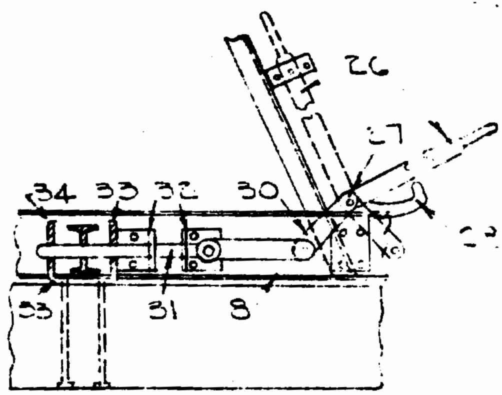


Fig. 4



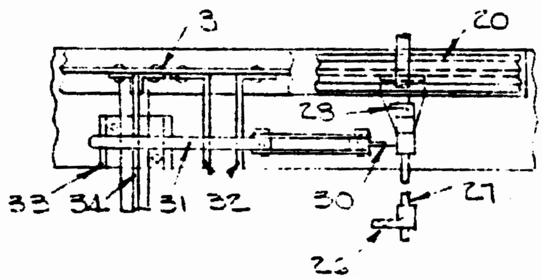
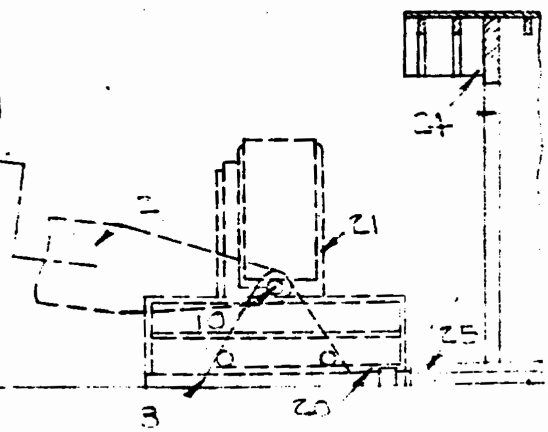


Fig. 5



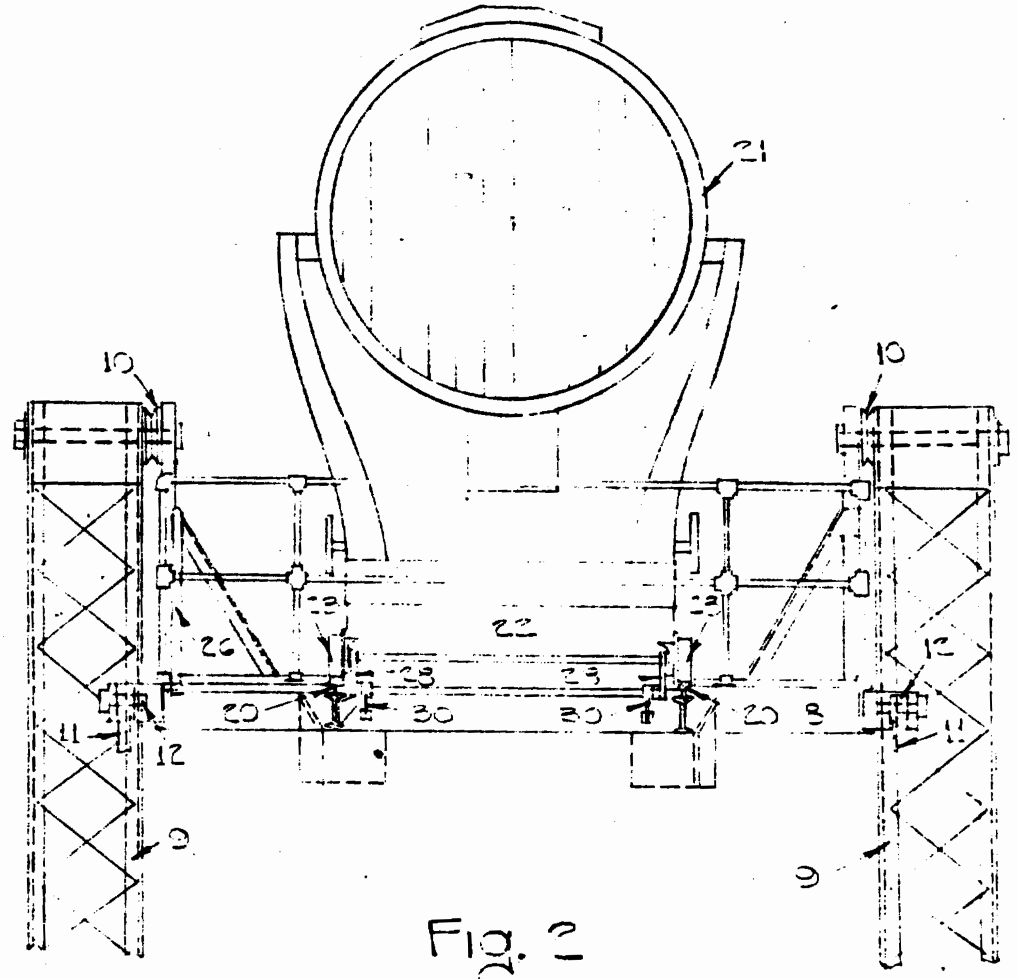
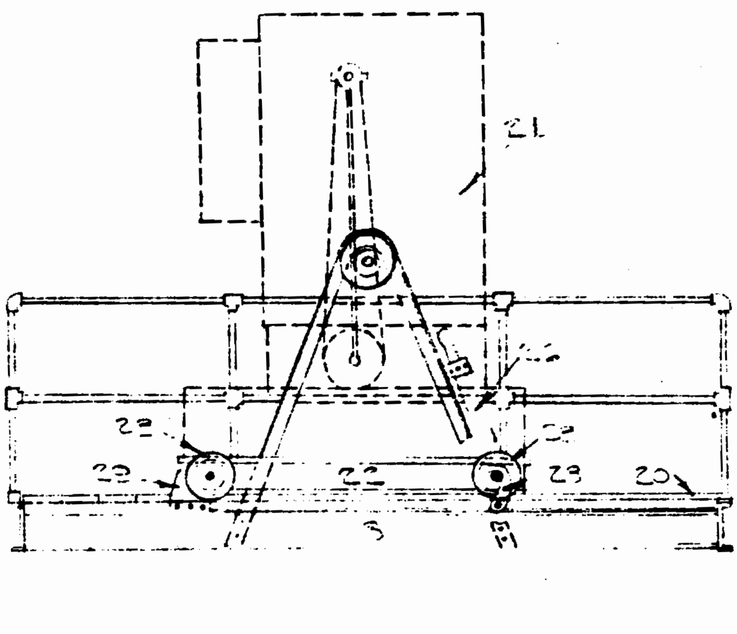


Fig. 2

Fig. 3



HEEL TRUNNION TYPE BASCULE BRIDGE

The bridge shown in Fig. 1 is composed of a movable span 1 provided with trusses 2. This span is pivotally connected with a fixed support which has trusses 4 which are in the same vertical plane as the trusses of the fixed support and the movable span abut, and there is a turning connection which movably connects them together. In the same line with the trusses is a pivot or trunnion 5 which works in a bearing 6. The trunnion is held in place by the inclosing piece 7 connected with the trusses. 2. AAssociated with the main span is a supporting frame 8 for supporting the counterweight 9. This counterweight is connected with a frame which is pivotally mounted upon the fixed tower or supporting frame 8. This counterweight is connected with a frame which is pivotally mounted upon the fixed tower or supporting frame 8. This counterweight frame has two portions, 10 and 10a. The part 10 containing the frame trusses is in the same vertical plane which contains the trusses of the movable span and the fixed support. The portion 10a containing a part of the members of the counterweight frame is on one side of this plane. The counterweight frame is connected with the movable span by means of a link 11.

One or more hooks 12 are connected with the frame 10 and are adapted to be hooked over a suitable member at the top of the span so as to hold it against further movement when it reaches its proper horizontal position. These hooks act as anchors to clamp the moving span to the fixed tower or supporting frame 8 and are preferably in the same vertical plane which contains the trusses of the movable span and the fixed support. These hooks form an anchoring device or part separate from the link through which the counterweight effect is transmitted to the movable span. This anchoring part being connected with the counterweight frame 10 automatically disengages from the span when it is opened, as shown in Fig. 2. It automatically engages the span when it is closed, as shown in Fig. 1.

An operating strut 13 is pivotally connected at 14 with the supporting frame 8 and is provided with a rack 14. A pinion 15 mounted on the movable span engages the rack, the pinion being operated by any suitable motor device. Mounted upon the operating strut 13 is a frame 16 provided with engaging wheels 17 which engage the strut. This frame is preferably mounted upon the shaft of the pinion 15 so as to be fastened to the span and slide upon the strut 13.

In Fig. 3 is shown a double deck construction in which the movable span 1 is provided with an upper floor 18. The counterweight frame 10 is extended toward the front and is provided with a floor portion 19 which forms a connecting part between the movable span and the fixed part, the fixed part also having an upper floor 20.

The counterweight is divided into two sections, one at each side and these sections pass on opposite sides of the roadway 20. When the bridge is closed, the floor 19 spans the space between the floor 18 of the movable span and the floor 20 of the fixed part.

Note that in both constructions, the hook 12 is disengaged and moved up when the span is open and automatically engages the span when it is lowered to its closed position. The movable span is outside of the boundary line of the end post 21 of the counterweight supporting frame 6. The inclined post 21 is provided with an extension 22 adjacent to the span, the span being mounted upon this extension. This allows the main span to open fully without striking the end post of the counterweight supporting frame, thus permitting a minimum length of the movable span for a given opening.

The construction with the trusses of the main span and fixed support in alinement permits the shortening of the floor members of the main and approach spans. Thus a smaller foundation may be used, greatly cheapening the construction. It also decreases the weight of the movable span and hence of the counterweight, which in a large bridge is a very important factor. This construction also permits two bridges to be placed side by side and to be made much closer together than with the ordinary construction. From this point of view it is particularly valuable in railway construction, as it thus avoids the spreading of the tracks.

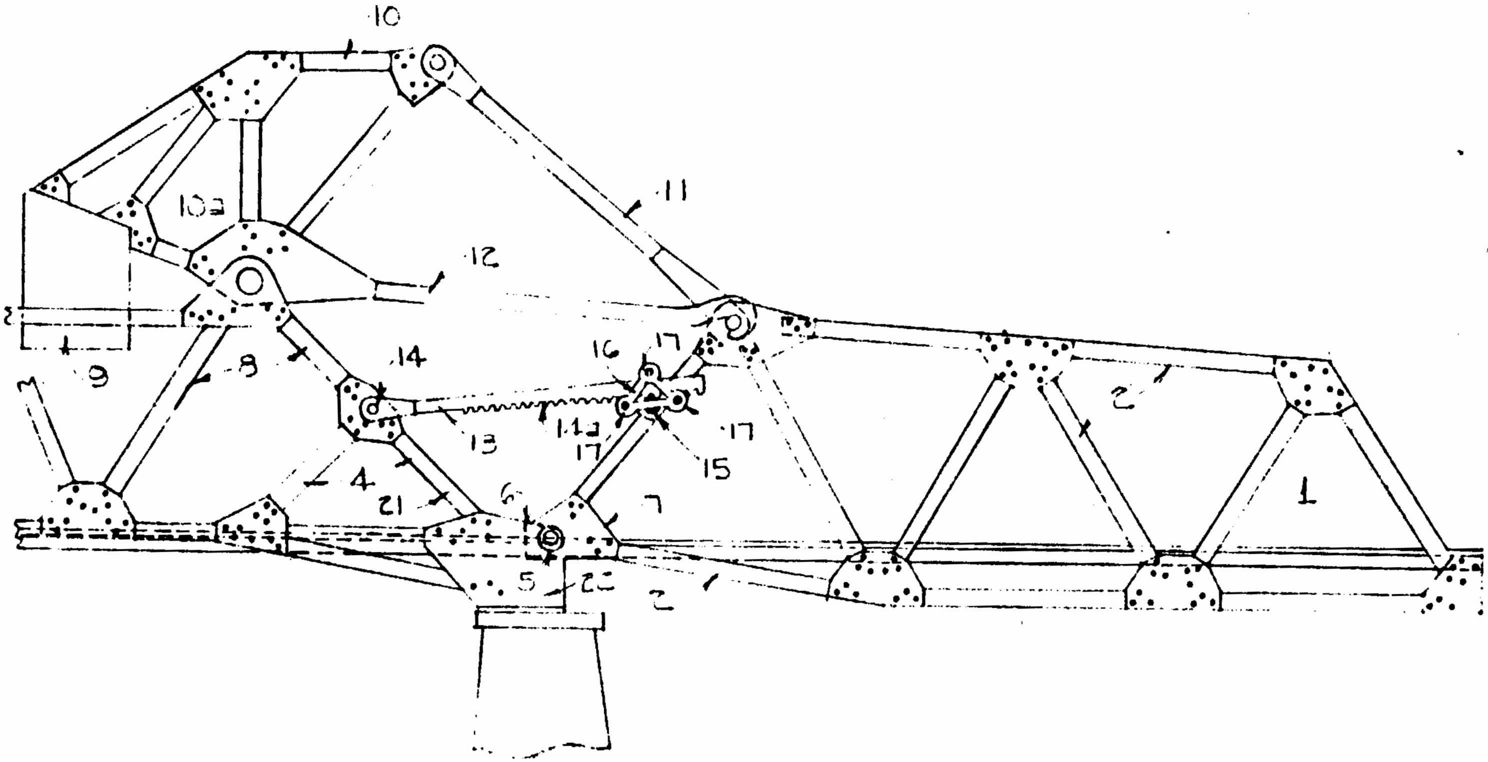


Fig. 1 - Heel Trunnion Type
(closed)

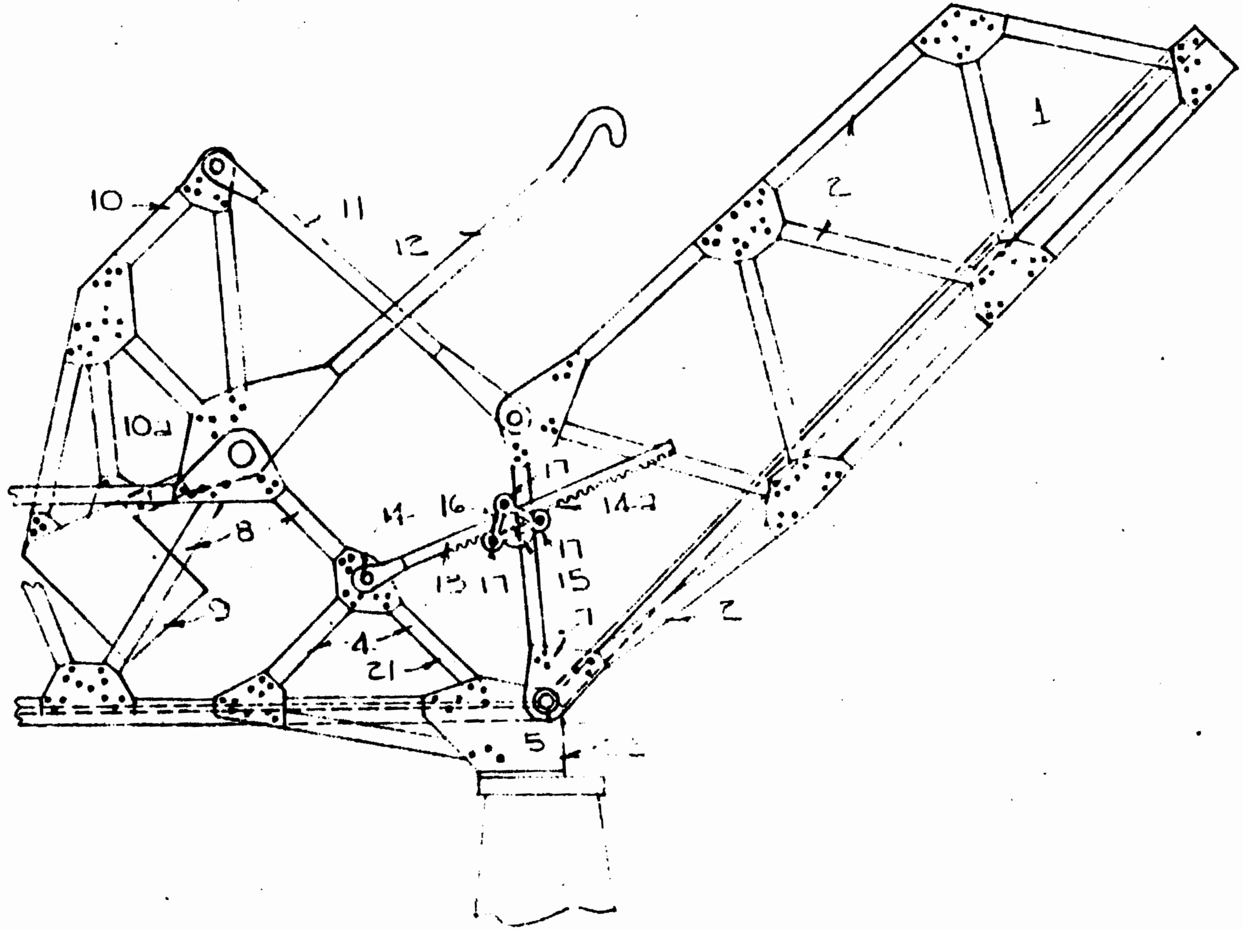


Fig. 2 - Heel Trunnion Type
(open)

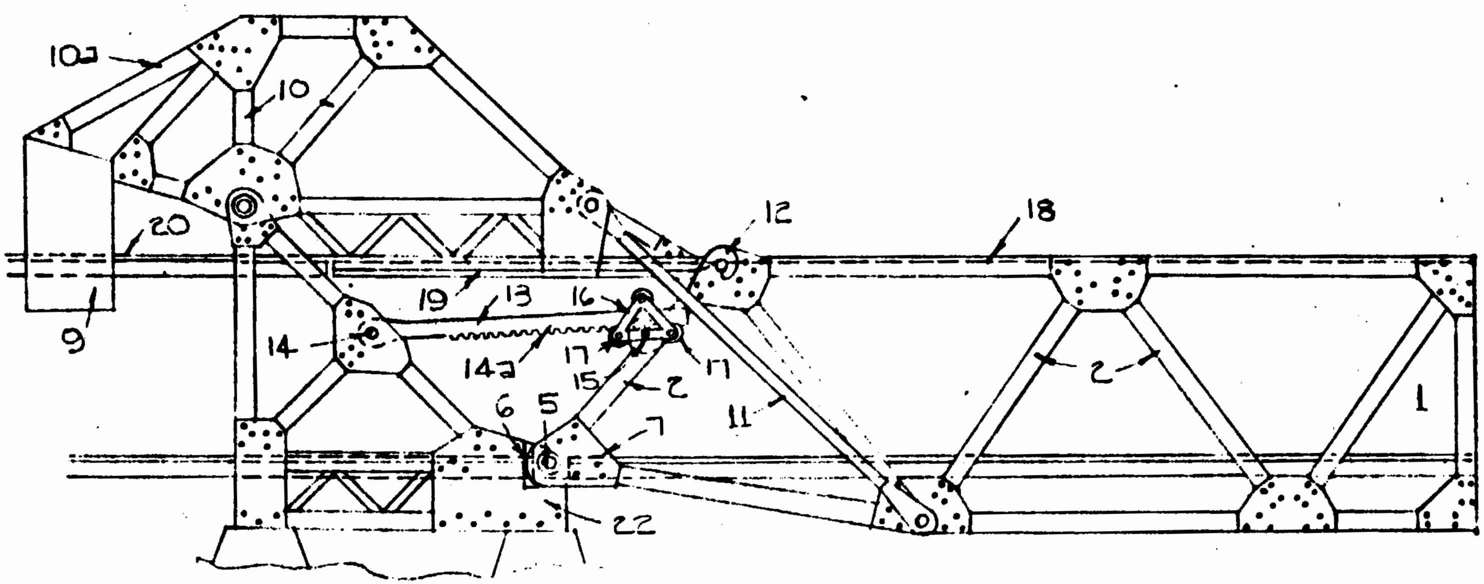


Fig. 3 - Double Deck Heel Trunnion Type
(closed)

OVERHEAD COUNTERWEIGHT TYPE BASCULE BRIDGE

A is the movable section extending across the part to be bridged. It is mounted on a support so that it may be lifted. This movable section has a rearwardly projecting part which extends behind the points where it is supported. The stationary supporting parts B_1 are provided, one on each side of the roadway to which are riveted the cross girders B_2 carrying the trunnions or bearings B on which the movable section rests and turns. Associated with the movable section is the counterweight C, which may be of any desired construction. This counterweight is provided with connecting pieces C_1 and C_2, by means of which it is connected to the end of the movable section by a pivotal connection C_3. The counterweight is also connected by links C_4 with a stationary supporting device D projecting above the roadway. There are two such devices, one on each side of the roadway. Thus, the counterweight ordinarily stands up above the roadway, as shown in Fig. 1. It is pivotally connected to the movable section, and it is also pivotally connected to the upwardly projecting stationary supports which extend above the roadway. These stationary supporting devices are arranged so that the movable section when lifted passes up between them. The counterweight at the same time passes downwardly and inwardly between them.

A suitable apparatus is used to operate the movable section. This apparatus consists of the operating struts E which are connected at one end with the movable section by being attached to the cross girder E_1 which runs transversely across the section and underneath it. These operating struts are provided on their under surfaces with racks E_2 which are engaged by pinions E_3 operatively connected with suitable motors. These operating struts pass through frames E_5 which are pivoted on the pinion shafts E_6 so as to be free to rock as the position of the strut varies. A compensating counterweight F is connected with each operating strut, this counterweight in turn being connected by a link F_1 with the frame E_5, the link being pivoted thereto. The compensating counterweight is mounted upon the strut so that the strut can move relative to it. This compensating counterweight therefore varies in position with relation to the strut so as to balance its upwardly projecting end as the strut is moved upwardly to lift the movable section. As the strut passes back, its free end overhangs the pinion while the length and weight of the end attached to the movable section decreases in respect to the pinion so that there would ultimately be an uplift at point F_2. The counterweight, however, remains constant in relation to the pinion and its mass is such that it overbalances the strut in its extreme position and thus keeps the effect on both the movable section and pinion constant.

When it is desired to lift the movable section, the motors are operated, and by means of the pinions and racks, the struts are moved so as to pull the movable section upwardly, moving it above the trunnion connections. When the bridge is completely lifted, the movable section and counterweight take the position shown in Fig. 2. The connecting piece C_4 is equal in length to the distance between the center of the trunnion B and the pivot C_3 and is parallel to a line drawn through these two points.

Also, a line drawn through the points B and the pivotal point C_5 of the connection C_4 is equal and parallel to a similar line drawn through the point C_3 and point C_6. These lines with the two fixed points B and C_5 and two moving points C_6 and C_3 form the elements of a parallel motion so that as the movable section rises and moves in toward the trunnion, the counterweight descends and moves in toward the trunnion in equal ratio, and thus the counterweight arm remains constant and the center of gravity remains in the center of the trunnion, keeping the bridge in equilibrium throughout its movement.

A means is provided for protecting the end of the bridge from extreme high water, that is, for preventing the end of the bridge from dipping down into the water when the movable section is lifted. This result is secured by providing a casing G supported upon the piers or bridge supports and arranged so that the end of the bridge can pass down into it. This casing may be made of any desired material, such as concrete, steel or the like, and is provided with an automatic drip which allows all water that may accumulate thereon on account of rain to escape. In the case of high water this casing will provide a pit, as it were, for the rear end of the movable section, and thus protect it. The bottom of the casing is above the normal level of the water.

The floor of the main span ends at the trunnions and the floor I, of the approach from the shore end to this point is fixed. The trunnions B, which are supported upon the stationary cross girders B_2, form the pivotal points about which the bridge turns. It will be seen that if the truss members of the main span extended back beyond the trunnions, they would engage the cross girders B_2

these cross girders B_2 as the bridge was turned up, and thus prevent its further movement. In order to prevent this, the main truss members end at the trunnions, and the rear end of the main span is provided with truss members K, K_1, K_2, K_3 which completely surround the cross girders B_2, that is the cross support for the main span. The truss member K_3 projects downwardly and forwardly and the truss member K projects from the rear end of the bridge downwardly and is engaged by the truss member K_3 and then passes up the main span. In this construction the cross support for the main span or movable section does not in any manner interfere with the lifting of the bridge.

The most preferable method of constructing the counterweight is to first construct a box of suitable size and shape, open so that the interior is accessible. The box is then filled in with loose counterweight material of any suitable kind. For example, large pieces of material may first be placed in the box and then the interstices filled in with smaller pieces or fine material until the total weight of box and material and associated parts provide the desired weight. By means of the connections, the box is prevented from tilting as the bridge is lifted and lowered, and hence the spilling of the counterweight material is prevented. When the bridgedis opened, the counterweight lowers to substantially the level of the roadway so as to act as a barrier across the roadway.

Notice that the counterweight is associated with and supported by a compound lever having a member pivoted to a fixed support and a second member pivoted to the first member at one end and to the rearwardly projecting end of the bridge span at its other end. One of these lever members is substantially parallel to a line which passes through the pivot of the bridge span and the point of pivotal attachment of the second lever member to said bridge span, and the other lever member substantially parallel to a line through the said pivot of the bridge span and the point of pivotal attachment of said first lever member to its support.

It will be noted that the counterweight is separated by a considerable space from the bridge itself, that is, from the main girders, and a considerable height above them. It will be further noted that the counterweight moves in a curve between the clearance line of the bridge and the roadway as the bridge opens, that is, the path of the counterweight is a curve extending from the clearance line of the bridge toward the roadway. The counterweight is suspended from or attached to a fixed part, and also to a movable part.

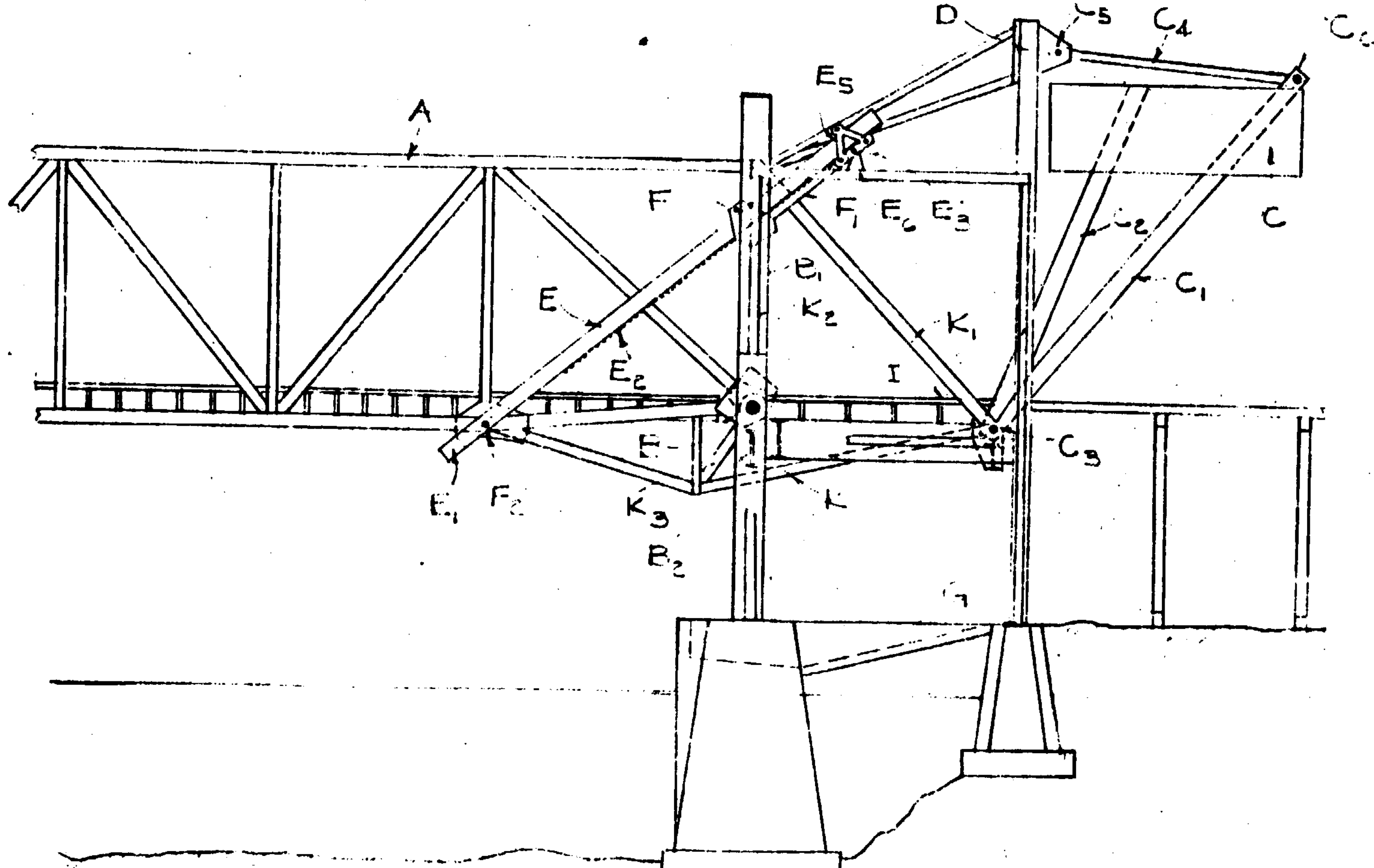


Fig.1- Overhead Counterweight Type
(closed)

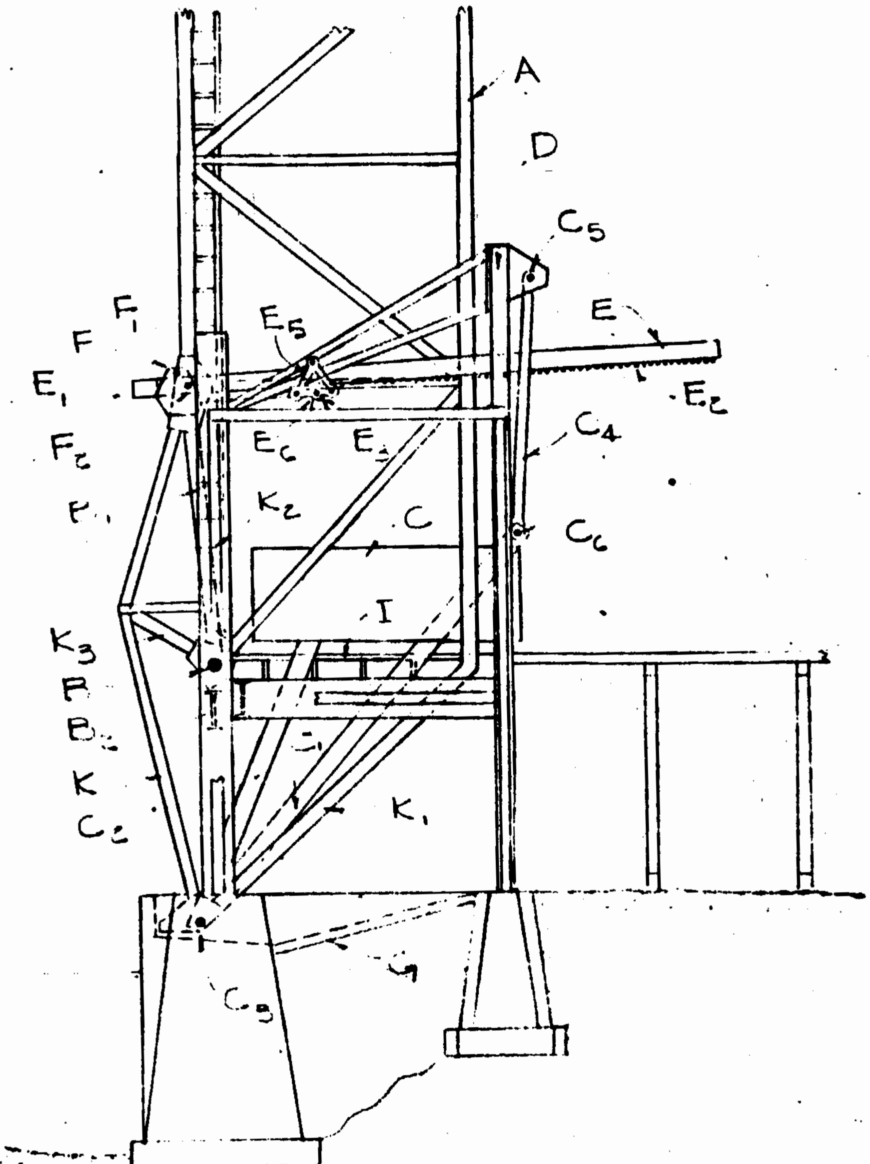


Fig. 2- Overhead Counterweight Type
(open)

UNDERNEATH COUNTERWEIGHT TYPE BASCULE BRIDGE

This design provides what may be called an underneath type of structure wherein the bridge, counterweight and the operating mechanism are all beneath the roadway.

The bridge may be a single span or there may be two spans, one on each side of the stream, the two connected together at the middle when in their operative position.

A main span A comprising suitable trusses A_1 is mounted upon suitable trunnions, or projecting pins B which work in bearings in the supporting posts C, the trusses passing in between the supporting posts. The trusses A_1 are connected together by cross pieces. By this arrangement, the supporting posts are symmetrically disposed with relation to the trunnions. There is also suitable bracing for the posts. The floor D of the main span does not extend all the way along the span, but stops at the point at one side of the trunnions. The rest of the floor E back to the abutment wall is fixed.

The counterweight F is located beneath the roadway floor E and may be made up in any desired manner. As shown, it consists of a main central cross girder F_1 and longitudinal girders. The main cross girder is a box girder having interior webs or diaphragms at right angles to the axis of the girder. The longitudinal girders are divided into two sections, the ends of which abut the cross girders and which are fastened thereto by the plates. At each side of the counterweight there is a counterweight pin F_3 cantelivered in the main cross girder. This pin passes through holes in the diaphragms and connects to a plurality of these diaphragms so that the pin reactions are transality of these diaphrams so that the pin reactions are transmitted to the main cross girder. These pins project beyond the counterweight into suitable bearings in the trusses. By this construction the counterweight is, as it were, concentrated at the points where the pins are connected with the main cross girder and is free to move with relation to the trusses so that the counterweight can keep its horizontal position. The counterweight pin and the trunnion of the main span are in line with the center of gravity of the main span, which is diagrammatically represented at C_1. A suitable floor is preferably associated with the counterweight girders. The counterweight is preferably cut away so as to receive the cross beams or stringers E_1 of the roadway floor when the bridge is down so that there would be no interference between the roadway floor and the counterweight. By this construction the counterweight extends toward the roadway floor between the stringers supporting said floor. Connected with the counterweight is a link F_5 which is pivoted to the counterweight and to the fixed support. This keeps the counterwei weight in a proper horizontal position during all the various positions of the main span.

The rear end of the main span, instead of being made up of curved members is composed of a series of straight members or chords of a circle I and radial members I_1 from the trunnion to the intersecting points of said chords.

Any suitable operating mechanism may be used for raising and lowering the main span. The main span is provided with a toothed rack J which is engaged by a gear wheel J_1 connected by suitable reducing gears to a motor J_2. This rack and the operating mechanism are beneath the roadway floor so as to be out of the way. When the bridge is in its operative position the parts are as shown in Fig. 1. When it is desired to lift the bridge, the operating mechanism is started and the main span moved about the trunnions as pivots. The counterweight moves down with the rear end of the main span, the rear end moving away from the fixed roadway floor, the counterweight keeping in a horizontal position and assuming the position shown in Fig. 2 when the bridge is up. When the bridge is lowered the parts take the position shown in Fig. 1. By this construction all the parts and operating mechanism are beneath the roadway so that there are no upwardly projecting parts or mechanism.

The fixed floor, the fixed support, the rear end and the counterweight are all adapted to work in the limited space between the underside of the roadway and the water line. The various parts are therefore recessed and otherwise adapted to fit into and clear each other during the operation of the bridge.

The fixed supports on which the trunnions are mounted and which are arranged in pairs, are so arranged with relation to the counterweight that part of the counterweight passes by them and in front of them when the bridge is open. These fixed supports or supporting posts are mounted upon bolsters, there being side braces for these posts also connected with the bolsters, the supporting posts, braces and bolsters acting as a unit. The movable section of the bridge is provided with main trusses which are associated with the trunnions and are provided with radial members radiating from the trunnions in straight lines toward the front and rear. The main span is provided with what may be called a double rear end member consisting of a member upon which the counterweight pins are mounted and the member acting as a bumper. The counterweight pin is in one line of action and the bumper I_3 in the other, the bumper acting at the rear of the counterweight pin. This bumper stops the main span when it has reached its lowered position by engagement with the stringer E_1 anchored by the member I_4, and holds it in place. The pressure of this bumper is resisted by the members I_4 which are properly anchored in any desired manner. The fixed floor and the main span have a joint support, that is, they are supported upon the same device. The support for the main span embraces members for the upward and downward forces with suitable connections between them. The members for the upward and downward forces consist of the posts C and the members I_4. The connection between these members is obscured by the truss and counterweight. It consists of a connecting piece on each side of the bridge.

The counterweight pins upon which the counterweight is supported are located in substantially the same horizontal plane as the center of gravity of the counterweight. The support for the main span embraces direct acting vertical supporting members for the upward and downward forces in a vertical plane with the trunnions and bumper and suitable horizontal bracing consisting of the floor and floor beams at the top.

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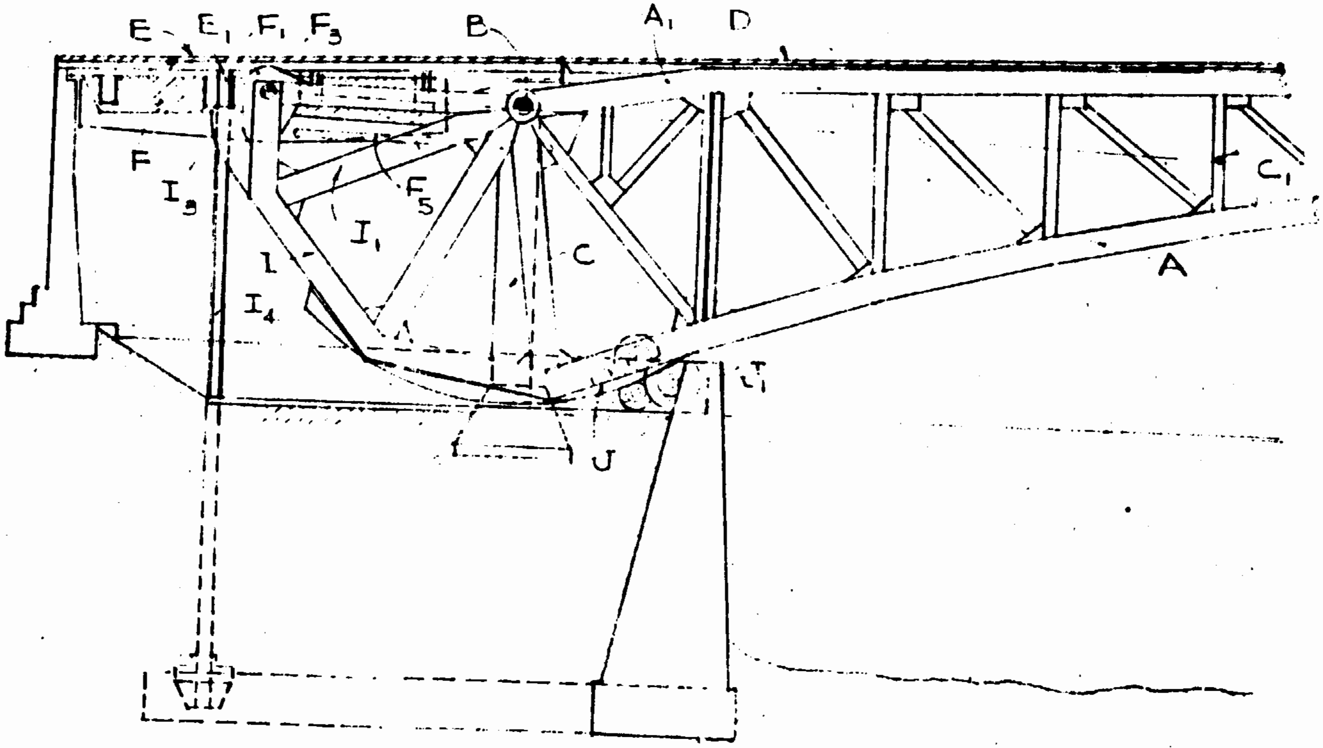

Fig. 1 - Underneath Counterweight Type
(closed)

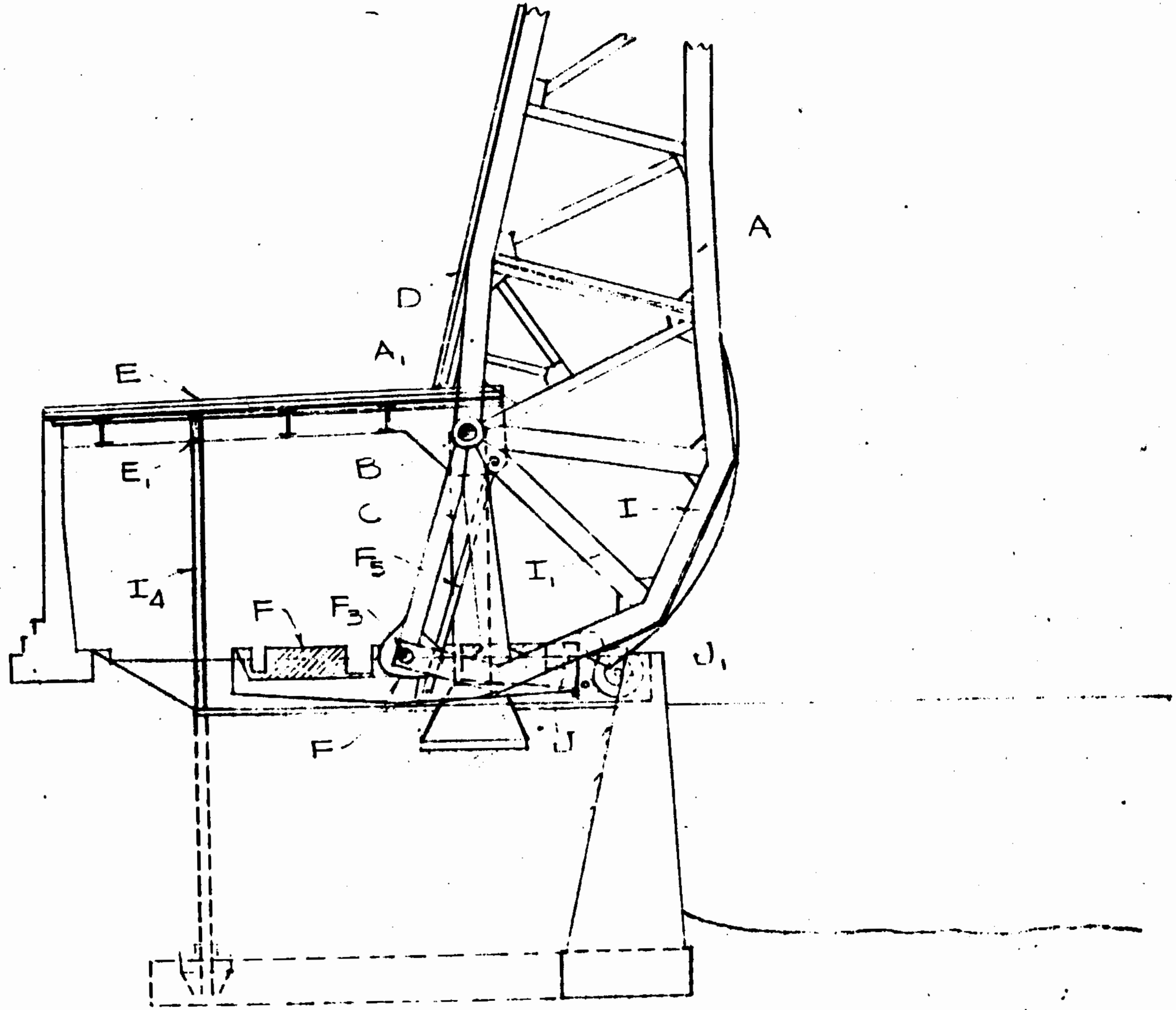

Fig. 2 - Underneath Counterweight Type (open)

SIMPLE SPAN TYPE BASCULE BRIDGE

Referring to the accompanying figures:

Fig. 1 is a side elevation of the bridge.

Fig. 2 is an enlarged view of a portion of the bridge support.

Fig. 3 is an enlarged side elevation showing the upper connection of the sections of the bridge.

Fig. 4 is a plan view of the connection shown in Fig. 3.

Fig. 5 is an enlarged side elevation showing the lower connection of the sections of the bridge.

Fig. 6 is a sectional view taken on line 6-6 of Fig. 5.

The two sections 1 and 2, are pivoted at their ends or heels to a suitable support at 3. These sections are arranged so that they may be opened by moving them about their pivotal connections. When lowered, the ends are connected together by a suitable connection which takes compression, shear and tension, thus forming a simple span.

The top chord 4 of section 1 is provided with a projection 5 which fits into a receiving space 6 associated with the top chord 7 of section 2, the arrangement being such that the projection becomes freely disengaged as the sections are lifted. This connection takes up compression, as shown in Figs. 3 and 4.

Tension in the bottom chords of sections 1 and 2 is resisted by a longitudinally disposed interlocking connecting device, as shown in Figs. 5 and 6. It consists of an engaging part 8, connected with the tension chord of one section of the bridge, and having an enlarged end or head 9 which fits into a receiving part 10 on the other section of the bridge as the sections are lowered to their closed position. The receiving part is provided with an enlarged receiving space 11 in which the enlarged end 9 is received, there being a smaller receiving space 12 which receives the reduced portion 13 of the engaging part 8, the arrangement being such that when the parts are engaged they cannot be pulled apart longitudinally. In other words, the engagement is such as to resist tension in the members. The parts 8 and 10 may be pivoted to the sections 1 and 2 or fixed in any other manner.

This construction permits the automatic engagement and disengagement of these parts when the sections are moved about their pivots 3. A suitable device is provided to prevent the movement of the parts 8 and 10 when in their engaging position. The links 14 and 15 are connected with the members 1 and 2. These links are pivoted to a controlling part 16 by means of which pressure can be applied to them to tend to move them into alinement. One part is pivoted to the member 1, for example, and the other part is provided with a fork which engages a pin or projection 17 on the other part. This arrangement permits the disengagement of the parts when the sections are lifted. The part 16 may be operated in any desired manner, as, for example, by means of the solenoid 18. The solenoid can be arranged so that the controlling part will be moved down when the solenoid is energized, or it may be moved down by a spring and released by the energizing of the solenoid.

When the parts are in the position shown in Fig. 5 and the controlling part forced downward, the lower ends of the sections are forced away from it, so as to cause the parts 8 and 10 to clamp each other. This prevents relative movement of such parts. The separation at the bottom of the sections 1 and 2 tends to bring them closer together at the top. Note that the ends of the sections 1 and 2 abut, and the engaging parts form a connection between them which takes up compression, shear and tension, and thus a simple bridge span is formed when the two sections are closed.

The sections 1 and 2 may be placed in position and used as an ordinary fixed span, and may then be converted into a bascule bridge at any later period by simply adding mechanisms for lifting one or both of the sections, and adding counterweights. This mechanism may be of any desired construction. As shown in Fig. 2, a support or tower 23 may be provided at one or both ends and mounted on suitable piers 24. Pivotally connected to these supports or towers are the counterweight frames 25, provided with the counterweight 26 and connected to the sections 1 and 2 by the pivoted connecting struts 27. Operating struts 28 are pivotally connected to the towers 23 and engage pinions 29 on the bridge sections, the struts having teeth to engage such pinion. A motor or other suitable operating mechanism for each pinion is placed upon the sections 1 and 2, the arrangement being such that when the operating mechanism is set in motion the sections of the bridge are lifted so as to open the channel. In view of the fact that the two sections form a simple span when closed, some suitable means should be provided for permitting expansion due to changes in temperature. As shown in Fig. 2, one of the supports or towers 23 is movably mounted so that it may move to permit this expansion when it occurs in either or both sections. The tower or support should be fixed when it is desired to lift the section of the bridge which is pivoted to it.

The support or tower 23 is loosely mounted upon the piers 24 in any desired manner, as, for example, by being mounted upon the rollers or balls 30. The support or tower 23 is provided with a locking part 31 which projects between the fixed parts 32 associated with the fixed member 33. Movable wedges 34 are provided which engage the fixed parts 32, the arrangement being such that when the movable wedges are lowered, the tower is free to move back and forth in response to the expansion of the material in the sections of the bridge. When it is desired to lift the sections of the bridge, these wedges are moved to their locking position as shown in Fig. 2, thus fixing the support or tower in position.

Before moving the wedges to their locking position, the section 1 may be moved toward the section 2 by rotating the pinion 29 in the proper direction, and the pressure between the locking or engaging parts on the two sections relieved so that the sections may be readily disengaged during the process of lifting. These wedges may be moved into position by hand when it is desired to open the bridge, or by any other means. The wedges are connected to the operating strut 29, the connection being such that when the strut is moved, they will be moved to their locking position. The wedges are connected to an equalizing bar 35 which in turn is connected to a pivoted lever 36. This lever is connected by a link 37 with the projecting end of the operating strut 29.

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When the section 1 is lifted, the wedges are pulled to their locking position and the towers are fixed in position. By means of this construction a double span bascule bridge is provided which does away with the uplift upon the foundations which is present in the ordinary double span bascule. The expansion due to variations in temperature of one member is transferred to the other member and taken up at a distance from the connection between the abutting ends of the sections.

The interlocking device or parts, which separably connect the abutting ends of the sections, that is, the parts 8 and 10, are parallel to the axis of the bridge.

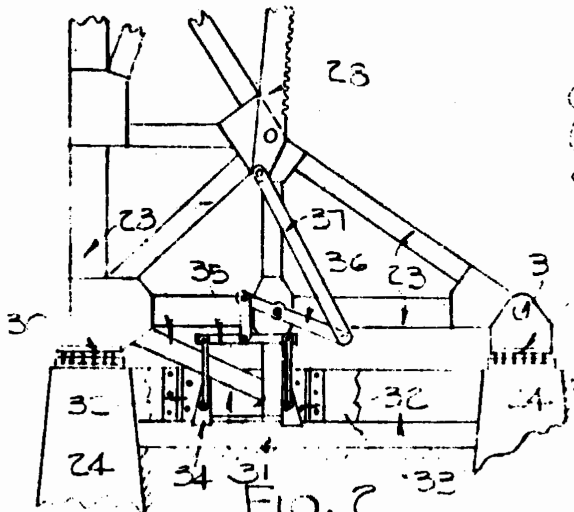

Fig. 2

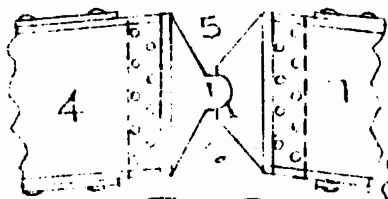

Fig. 3

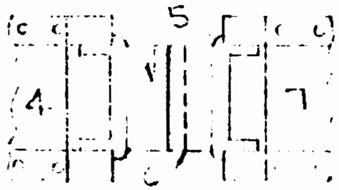

Fig. 4

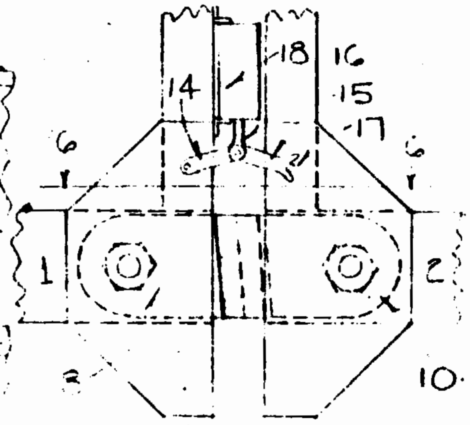

Fig. 5

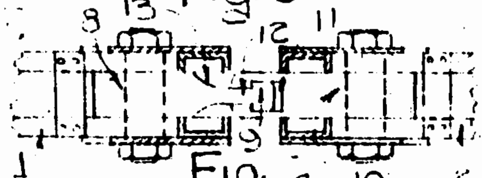

Fig. 6

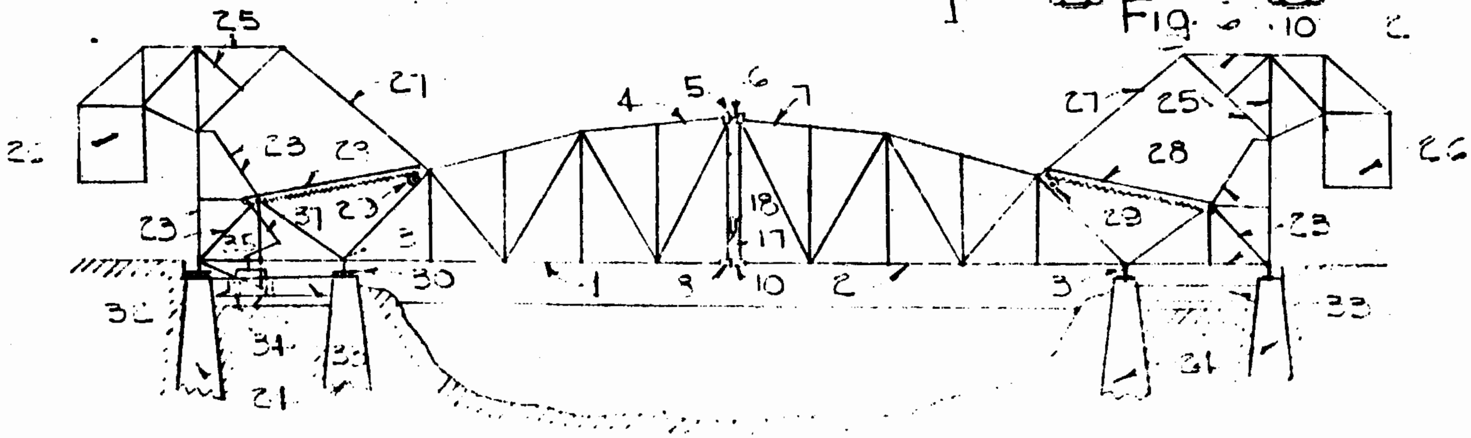

Fig. 1
Simple Span Type

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SUMMARY STATEMENT

Joseph Strauss planned and directed the building of structures greater than any ever before erected by men, yet he found time to continue his contact with the city of his boyhood.

He was presented with the honorary degree of Doctor of Science at the 1930 University of Cincinnati commencement exercises. Awarding Strauss his degree was another famous man: Dean Herman Schneider, president of the University in 1930, who, in 1906, had founded the now world-famous cooperative system of technological education.

Joseph Strauss honored his alma mater in a special way during the construction of the Golden Gate Bridge. When he learned that U. C.'s first building, old McMicken Hall[35], was to be razed, he had one of its bricks sent to him. With his own hands he placed that brick in the San Francisco anchorage, with the prayer that the tradition it represents would be preserved for all time in the heart of the pier of the world's most gigantic bridge.[36]

The Cincinnati boy who dreamed of doing something no one had ever done before, died at Los Angeles on May 16, 1938, less than a year after his dream was completed. He was buried in Forest Lawn Memorial Park at Glendale, California.

Today, on a granite pedestal at San Francisco is a seven ft. bronze statue of Joseph B. Strauss, dressed in a business

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35. The Charles McMicken homestead on lower Clifton Ave., in which Strauss had attended classes.
36. Times-Star, (May 27, 1937).

suit, with a roll of blueprints in his hand, looking westward through the Golden Gate. Incised in the pedestal is the inscription: "Idealism and action united to form the creative power of this achievement."

In writing this report, my objective has been to discuss the inspiring story of Strauss's life and to describe many of his accomplishments. I sincerely hope that I have added some useful knowledge to the records of our University regarding one of its most distinguished graduates.

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