Jan. 24, 1956 J. W. LUDOWICI 2,732,177

APPARATUS FOR HOISTING HEAVY SLABS

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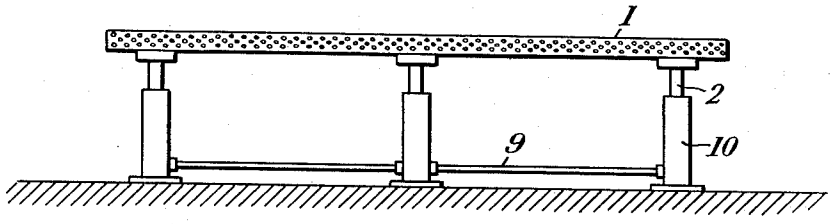


Fig. 1.

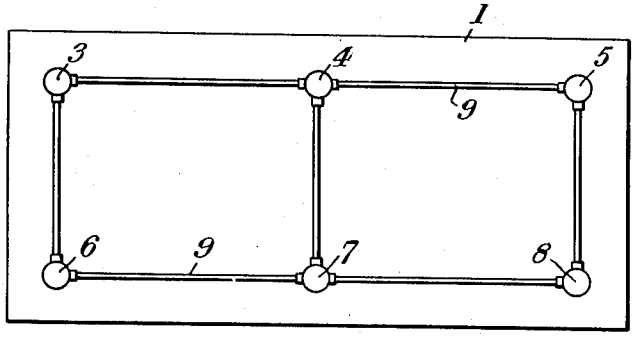


Fig. 2.

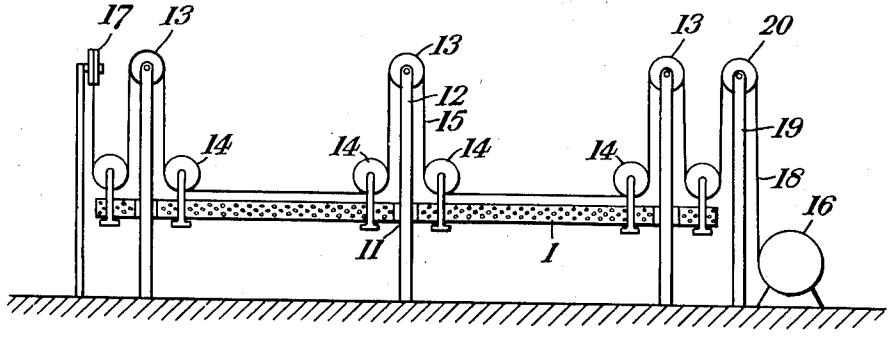


Fig. 3.

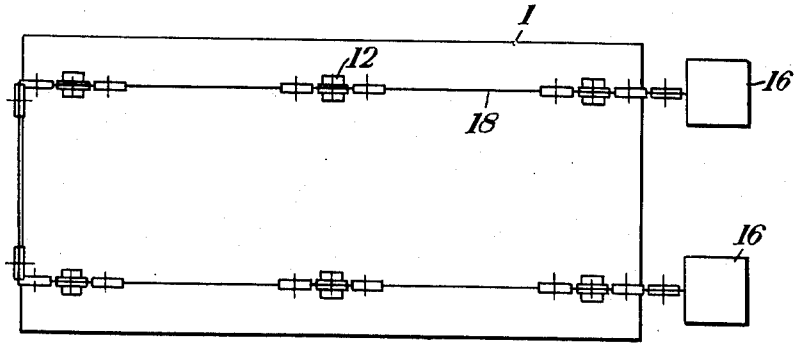


Fig. 4.

INVENTOR:
JOHANN WILHELM LUDOWICI
BY:

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APPARATUS FOR HOISTING HEAVY SLABS

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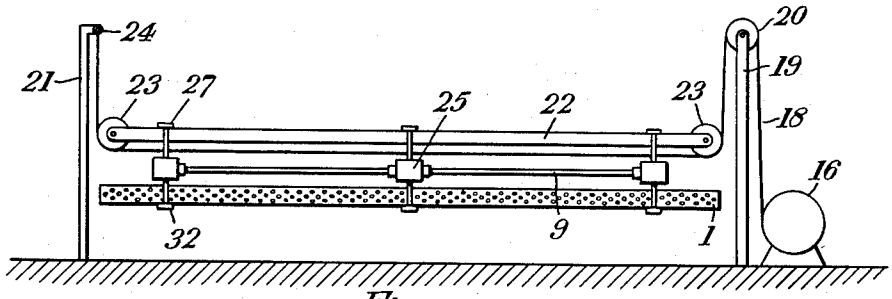


Fig. 5.

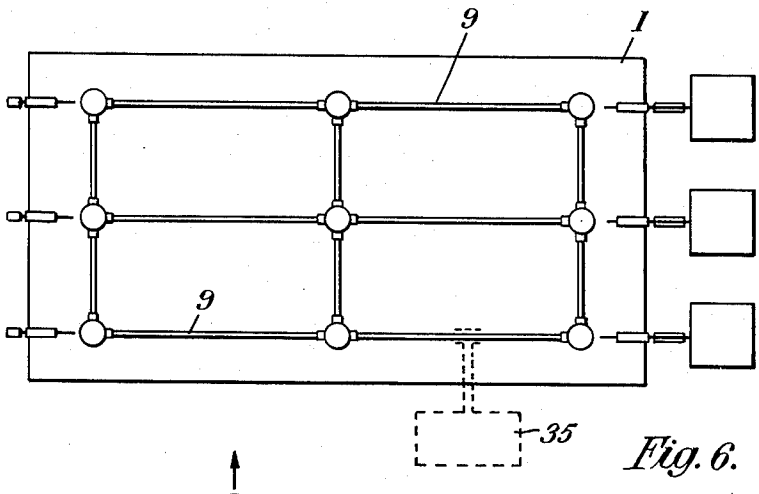


Fig. 6.

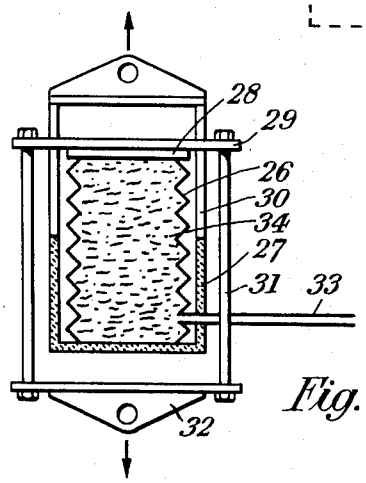
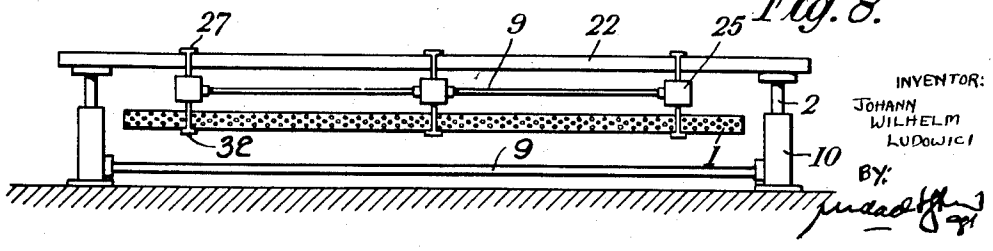


Fig. 7.

Fig. 8.



INVENTOR:
JOHANN WILHELM LUDOWICI
BY:

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APPARATUS FOR HOISTING HEAVY SLABS

Johann Wilhelm Ludowici, Jockgrim, Pfalz, Germany

Application September 18, 1953, Serial No. 381,630

6 Claims. (Cl. 254—89)

This invention relates to apparatus for hoisting heavy slabs, such as, for example, reinforced concrete floors or ceilings.

It is an object of the invention to provide a method and apparatus for uniformly raising up heavy reinforced concrete slabs such as floors, ceilings, or like structural members whilst maintaining their horizontal position and avoiding undesirable bending stresses. It is necessary, in order to raise massive and heavy structural members of this nature, to apply tension or pressure at a plurality of points on the structural member. Experiments with winches, the cables of which were secured to a heavy slab at six places, showed that with the slightest difference in the operation of the six winches bending stresses were set up in the slab which caused it to fracture.

According to the invention perfectly uniform stress-free hoisting of such heavy structural members is achieved by providing means for equalizing all the lifting tensions or pressures. The equalizing means must be arranged and constructed in such a manner that exactly the same force is exerted at all the points of application of the tension or pressure devices, and that any increase or diminution of the force at any point of application is automatically cancelled out in the shortest possible time.

The equalizing means according to the invention may be based on hydraulic, pneumatic or mechanical principles. If the hoisting is to be effected by means of pneumatic or hydraulic cylinders, according to the invention, the individual hoisting cylinders are inter-connected by pipes in such a manner that with the same working pressure applied to each cylinder only the same lifting force can be exerted.

If cables are used for hoisting the slabs equalizing of the cables is effected according to the invention by causing all the cables to exert the same force. Such equalizing can quite simply be brought about in the case of two cables by interposing an intervening pulley. Moreover, the various secondary frictional forces can be taken into account with an equalizing of this kind.

An embodiment of the invention consists in interposing the equalizing means between the hoisting gear and the load. To this end, in accordance with a feature of the invention, there is provided, in association with each point of application of the force to the structural member to be lifted a glandless cylinder, similar to a bellows, all the cylinders being inter-connected by equalizing piping. In this manner, the force acting at a given point of application will always rise or fall by such an amount that said point exerts the same force as is exerted at all the other points of application.

Further features and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying drawings which illustrate diagrammatically and by way of example, several embodiments thereof, and in which:

Figs. 1 and 2 are an elevation and plan view respectively of one embodiment using hydraulic rams;

Figs. 3 and 4 are similar views of another embodiment using hoisting cables;

Figs. 5 and 6 show similar views of a further embodiment employing hoisting cables;

Fig. 7 is a detail of an equalizing member of the last-mentioned embodiment; and

Fig. 8 is an elevation of a still further embodiment which is a combination of the embodiments of Figs. 1 and 2 and 5 and 6.

Figs. 1 and 2 show how a structural floor slab **1** is engaged at six points **3**, **4**, **5**, **6**, **7**, **8**, by pneumatic or hydraulically operated rams **2**. The floor slab must be supported in such a way that no bending moments of any kind can be set up therein. Equalizing of the pressure medium takes place by means of connecting piping **9** between pressure cylinders **10**, so that equalizing of the lifting forces occurs automatically.

Figs. 3 and 4 show a mechanical hoisting device with automatic equalizing of the lifting forces. The structural floor slab **1** is provided with apertures **11** for pillars **12**, the ends of which carry pulleys **13**, which latter together with additional pulleys **14** and a cooperating cable **15** constitute a link polygon arrangement which is operated by winches **16**. The pulleys **14** are mounted in brackets which are secured to the slab **1**. The cable **15** passes over all the pulleys of the pillars and the slab and is looped up by means of guiding pulleys **17**, whilst the ends **18** of the cable pass to the winches **16** over two reversing sheaves **20** mounted on pillars **19**. Since the cable tension has the same value at any point, the force exerted on the pulleys **14** fixed to the slab is always the same, that is to say, the slab can be hoisted without any bending moment.

Another mode of hoisting slabs is shown in Figs. 5 and 6. Pillars **19** are erected at the front end of the slab **1**, the tops of which are provided with pulleys **20**, whilst a corresponding pillar **21** serves for securing the end of the cable. The cable **18** passes from the winch over pulley **20** to pulleys **23** fixed to a support **22** and the end thereof is made fast to a clamping point **24** on the pillar **21**. Equalizing members **25** are interposed between the support **22** and the slab **1**, the construction of which is apparent from Fig. 7. A bellows **26** is mounted in a cylindrical housing **27**, its lower end being sealed hermetically to the bottom of the housing, whilst the upper end is sealed hermetically to a plate **28**. This plate **28** is extended in the form of two opposing arms **29** which pass through slots **30** in the cylindrical housing **27**, connection with the lower suspending lug **32** being made through tension bars **31**. The bellows **26** is provided with an external connection **33**, and all the members **25** are interconnected by piping **9** (Figs. 5 and 6).

When the cable **18** is wound in with the aid of the winch **16**, the support **22** is raised. The equalizing members **25** transmit the hoisting movement through the pressure medium **34** to the slab, this being done in such a way that automatic equalizing of the lifting forces occurs depending on the loading gradient at the various points where lift is applied, so that the slab is hoisted without any bending moment. All the equalizing members with the appropriate piping **9** can be placed under positive pressure by means of a pressure vessel **35**; the effect of this is that since the equalizing range of the bellows **26** is limited, equalizing only occurs at a definite load level.

Fig. 8 shows a similar arrangement, which is a combination of Figs. 1 and 2 and 5 and 6. The ends of the supports **22** are raised by pneumatic or hydraulic cylinders. The equalizing members **25** are arranged in a similar manner to that shown in Figs. 5 and 6.

I claim:

1. A hoisting apparatus comprising, in combination, a rigid supporting member adapted to extend in horizontal direction along a structure to be lifted; operating means

for raising and lowering said rigid supporting member; a plurality of spaced equalizing members, each equalizing member including two parts movable relative to each other and defining together a pressure chamber of variable volume adapted to contain a fluid pressure medium, one of said parts being attached to said rigid supporting member and the other of said parts including means for connecting the same to a structure to be lifted; and conduit means interconnecting said pressure chambers of said equalizing members for equalizing the fluid pressure in the same whereby the forces transmitted by said equalizing members between said rigid supporting member and the lifted structure are equalized.

2. A hoisting apparatus comprising, in combination, a rigid supporting member adapted to extend in horizontal direction along a structure to be lifted; operating means for raising and lowering said rigid supporting member; a plurality of spaced equalizing members, each equalizing member including two parts movable relative to each other, one of said parts including bellow means secured to the other of said parts and defining a pressure chamber of variable volume adapted to contain a fluid pressure medium, one of said parts being attached to said rigid supporting member and the other of said parts including means for connecting the same to a structure to be lifted; and conduit means interconnecting said bellow means of said equalizing members for equalizing the fluid pressure in the same whereby the force transmitted by said equalizing members between said rigid supporting member and the lifted structure are equalized.

3. Hoisting apparatus comprising, in combination, a plurality of spaced hydraulic jacks, each hydraulic jack including a cylinder member, and a piston member slidable in said cylinder member and defining with the same a pressure chamber adapted to be connected to a source of fluid pressure, one of said members being reciprocable and the other of the members being stationary; a rigid supporting member adapted to extend in horizontal direction along the structure to be lifted and being located above said hydraulic jacks and being supported by said reciprocable members of said jacks for being raised and lowered; a plurality of spaced equalizing members, each equalizing member including two parts movable relative to each other and defining together a pressure chamber of variable volume adapted to contain a fluid pressure medium, one of said parts being attached to said rigid supporting member and the other of said parts including means for connecting the same to a structure to be lifted; and conduit means interconnecting said pressure chambers of said equalizing members for equalizing the fluid pressure in the same whereby the forces transmitted by said equalizing members between said rigid supporting member and the lifted structure are equalized.

4. A hoisting apparatus as claimed in claim 3 wherein said equalizing members are located underneath said rigid supporting member and downwardly project from the bottom face thereof so that said rigid supporting member is adapted to be located above the lifted structure.

5. A hoisting apparatus as claimed in claim 3 wherein one of said two parts of said equalizing members includes a cylindrical housing and a bellow means secured at one end thereof to said cylindrical housing and being located in the same, said cylindrical housing being formed with axially extending slots; and wherein the other of said two parts includes a first transverse member passing through said slots and being secured to the other end of said bellow means, a plurality of tension bars secured at one end thereof to said transverse member, and a second transverse member connecting the other ends of said tension bars.

6. Hoisting apparatus comprising, in combination, a plurality of spaced hydraulic jacks, each hydraulic jack including a cylinder member, and a piston member slidable in said cylinder member and defining with the same a pressure chamber adapted to be connected to a source of fluid pressure, one of said members being reciprocable and the other of the members being stationary; a rigid supporting member adapted to extend in horizontal direction along the structure to be lifted and being located above said hydraulic jacks and being supported by said reciprocable members of said jacks for being raised and lowered; a plurality of spaced equalizing members, each equalizing member including two parts movable relative to each other, one of said parts including bellow means secured to the other of said parts and defining a pressure chamber of variable volume adapted to contain a fluid pressure medium, one of said parts being attached to said rigid supporting member and the other of said parts including means for connecting the same to a structure to be lifted; and conduit means interconnecting said bellow means of said equalizing members for equalizing the fluid pressure in the same whereby the forces transmitted by said equalizing members between said rigid supporting member and the lifted structure are equalized.

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