ELECTRICAL WIRING DESIGN FOR A FACTORY BUILDING

THESIS FOR THE DEGREE OF B. S.

Lawrence A. Strobel

1930

Electric wiring
Mill + factory buildings

Electrical engineering

ELECTRICAL

WIRING DESIGN

For A

FACTORY BUILDING

THESIS FOR THE DEGREE

Of B.S.

LAWRENCE A. STROBEL

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THESIS

ACKNOWLEDGEMENT

I wish to express my appreciation to Prof. Foltz who suggested the topic treated and for his guidance and encouragement; Mr. Frank Bigelow whose timely suggestions and criticisms were most helpful in making my work conform to common practice in Factory Electrical Layouts; the Bull Dog Electric Products Company and the Benjamin Electric Company for the catalog leaflets and information furnished; and to various architectural and engineering firms whose specifications I have used as guides in compiling these specifications.

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I have selected this subject as a thesis for several reasons: first, from a selfish desire to learn more about a subject which will probably yield me my life work; second, from a desire to present the latest designs in modern, flexible power installations for the greatest of power users - the manufacturers of the automobile in all its forms; fourth, from an ethical and engineering standpoint.

If anyone is to raise the standard of power installations it must be the engineer for upon him the architects, who design the buildings, depend for adequate, economical, electrical installations.

Then, he must so design and write the specifications that the work, when figured, will be clearly defined and easily understood.

This stipulation is made for the reason that there is so much left out of specifications today that it leaves too much to the judgment of the contractor. It would be a fine thing if the contractors merited this trust, and if contracts were awarded on the basis of the reputation of the contractors for good work. But, since the average contract is let on the basis of price these "loop holes" and "questions of doubt" in the specifications encourage "cut price" and "illegitimate" contractors to bid low and then to cut a good job apart. There are a great many of these contractors doing business today in just this way.

The question naturally arises, why do people patronize this sort of a concern? The answer is obvious: the average person builds but once in his lifetime and when he does build he is anxious to get his work done as economically as possible and usually this economy is measured in a monetary way rather than on the basis of quality.

If he is letting the work by contract through an architect, the plans are usually secured by the contractor through the architect or the consulting engineer.

The contractors bid is based on the plans, specifications and the reputation of the engineer as regards his firmness in holding the contractor to the letter of the plans and specifications.

The responsibility for the proper execution of the plans and specifications is on the engineer. He must supervise the job.

Some jobs are let on figures that are so low that they are ridiculous. Contractors are in business primarily to make money and not to see how much lower they can take a job in comparison with competitors. Therefore, when his bid is so low as to be ridiculous either he has made a mistake in figuring or he is figuring on doing less work, using cheaper materials, labor, or on getting a lot of extra work at an unfair price.

The duty then of an engineer is to so completely supervise his work that the contractor will be required to do the same class of work his competitors were planning on doing. In this manner he will be maintaining the desired standard and will again the esteem of the legitimate contractor and enjoy the reputation of being a man of his word.

With a working knowledge of the present engineering methods, and the requirements of the particular installation, the engineer becomes the adviser and should keep constantly in mind the ideal that "what is worth doing at all is worth doing well". And, once he has decided what is the proper installation for a building he should not compromise on an installation which is barely adequate to meet present needs and which will be obsolete in less than the life of the materials he is specifying for installation.

This firmness should not take the manner of narrow mindedness but much the manner of the adviser who is basing his recommendations on past experience and probable future requirements.

It would, no doubt, be well to trace a little history of the advancement of the electrical field.

The first power was developed by steam engines and transmitted by a long line shaft through a building. As the factory expanded more buildings were added and the

steam engine was then belted to a dynamo which transmitted power to large electric motors in the various buildings driving these long line shafts.

Then the loads increased and more motors were added driving shorter shafts. But, the disadvantages were: the necessity of driving a long shaft with perhaps only one machine, with all the necessary connecting belts, the hazards of the overhead belts, and the reduced illumination due to them. The accompanying low power factor due to its light load, and the resulting penalty charged by power companies who, in the meantime have made it uneconomical for individuals to manufacture their own power, have brought us to our present ideal of individual drive.

Other advantages of the individual drive are increased illumination, flexibility of arrangement of machines, ease of movement of machines to another part of the shop where they will produce increased economies of production due to better arrangement.

Since the individual drive has advanced its merits to the place where it is no longer a questionable expenditure its economies have overruled this prejudice. the only hindrance to its flexibility is the power supply and the economic loss of scrapped materials whenever it becomes necessary to move a machine.

In automotive manufacturing today new models call for rearrangement of production lines and the resulting scrapping and salvaging of vast amounts of conduit and wire.

Since factories must keep pace and make this rearrangement annually or oftener it becomes imperative that the engineer make his layout as flexible as possible and adequate to meet these changing needs with the minimum economic loss.

Let us trace the advancement of electrical construction and wiring methods to meet these needs.

When the steam driven line shaft was replaced by the electric motor driven line shaft, electrical construction power wiring first came into being, (open wiring) or wire strung on cleats or knobs served the purpose in the old wooden buildings. When factories became fireproof electric wires were run in conduits. But since rigid conduit, one in place, cannot be readily moved without some scrapping, it became necessary to make another step forward and that makes itself known in the form of "bus-duct".

The problem which we have before us when we start to design a practical power installation for a building to be used for production manufacturer of machines is one which has been brought about by the rapid advancement of production methods in this machine age.

The paramount reason for individual drive lies in the fact that with its motor starter and disconnecting switch mounted all on the machine, it becomes a unit which is very flexible in its placement for production purposes making it easily and quickly moveable.

For in modern manufacturing, production methods may make it necessary to move any machine or the whole department during

one night. If this becomes necessary, as it frequently does, the engineer who designs the power layout for such a manufacturing building must make this one of the deciding factors in his selection of the type of layout.

Originally the power layout was merely one of carrying wires to the one motor which was done in "open wiring" with wire of proper size which was fastened with porcelain knobs.

Conduit soon found its way into these buildings, and in recent years conduit has been used quite extensively in complicated layouts.

Since the use of conduit involves the use of a permanent and rigid installation which does not lend itself to a quick move, and requires the machine to be idle at least long enough to make the necessary new installation, which in most cases would be at least a day or more, the engineer must select equipment and devices which are much more flexible.

Such equipment has been recently developed and I shall use it in this design. I shall also draw a comparison between this installation of bus-duct and a similar layout using conduit.

It will be my aim then in this thesis to design a power layout which will be a step forward in the advancement of the art contrasting it with the usual rigid conduit layout as regards flexibility and cost of installation.

The various paragraphs in the specifications are so arranged that the various requirements will come in the logical order which the contractor would follow in preparing his bid.

The electrical section is arranged in the same manner and with respect to the order of work in executing the installation.

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S P E C I F I C A T I O N S

of all materials and labor required for the construction and completion of a factory building to be located on the Pere Marquette Railroad Siding at Lansing, Michigan, in conformity with the accompanying drawings prepared by:

Lawrence A. Strobel

Thesis for the Degree
of B.S. in E.E.

The drawings referred to herewith consist of sheets of scale and detail drawings and manufacturers cuts now prepared or which may be prepared during the progress of the work.

INSTRUCTIONS TO BIDDERS
FACTORY BUILDING

LANSING MICHIGAN

PROPOSALS

Sealed proposals will be received at the office of the Engineer from Electrical Contractors up to and not later than two o'clock P.M. Eastern Standard Time, Monday, June 23, 1930. These proposals shall be enclosed in a plain opaque envelope plainly marked "PROPOSAL FOR ELECTRICAL WORK". for "A FACTORY BUILDING, LANSING, MICHIGAN".

Proposals shall be made in duplicate on forms herein provided, and each bidder is required to fill in all blanks in typewriting, or copy the entire form, word for word, on the bidders own stationery, indicating definitely the makes or manufacturers of all main items of equipment included in his proposal. This applies also to the statements regarding any sub-contractors.

Submitted proposals will be considered as final and no alternate or revised proposal will be accepted after the closing date above mentioned. No oral, telephonic, nor telegraphic proposals will be considered.

Proposals shall be signed by the Bidder, giving business address, and stating whether as individual, partnership or corporation; if the latter under the laws of what State. He shall also state what position he holds in the firm.

DOCUMENTS

Drawings and specifications are on file and may be seen at the office of the Engineer, Lansing, Michigan.

Bidders desiring to take the documents from the offices may do so upon deposit of TWENTY FIVE DOLLARS ($25.00)

All drawings, specifications, and other contract documents are the property of the Engineer and are instruments of service only. They shall be returned to his office.in an unmutilated condition and without any marks of annotations within one week after delivery of proposal providing the contractor is unsuccessful in securing the contract. In the event that he is sufcessful the plans shall remain his property for record purposes only, and must not be used nor copied for other than the particular job for which they are drawn. All checks for plans shall be made to the order of the Engineer.

BULLETINS OR ADDENDA:

Any Bulletins or addendas issued during the time of bidding shall be covered in the proposal and in closing the contract they will become a part thereof.

CERTIFIED CHECK

The bidder must submit with his proposal a certified check in a sum at least equal to 5% of the amount of each proposal, drawn to the order of the Engineer.

DEFAULT

If the bidder default in signing the Contract within five days after the written notification from the Engineer or Owners of the acceptance of his proposal, then the above mentioned certified check shall become the property of the owners. Checks submitted by bidders will be promptly returned to them after

DEFAULT-CONT'D

the approval of the contract executed by the successful bidder.

BONDS

The Contractor to whom awards are made will be required to furnish Surety Company bonds within ten (10) days following the official notice of the award of the contract. The form of the bond must be acceptable to the owners or their attorneys.

This bond must be not less than 25% of the amount of the contract, to satisfy the owners as to the faithful performance of said contract, and to protect the owners for any loss resulting from claims for infringement of patents covering any equipment used in the installation. In addition to the above this bond is to insure the owners against defective materials or workmanship in any work under this contract for a period of two years after the completion and final acceptance of the work.

The contractor to whom this contract is awarded will also be required to furnish a surety bond for the full amount of his contract, to protect the owners for the full payment of all wages earned and material used in the execution of the contract.

The above bonds will be arranged for by the contractor but he shall not include the cost of same in his proposal as the premiums will be paid by the owner.

BASIS OF PROPOSALS

Proposals shall be based on the methods and materials shown on the plans or described in the specifications. If alternate materials or methods are proposed or mentioned by the bidder in the proposals such shall be considered only from bidders submitting. In the event a bidder desires to furnish equipment other than specified he shall submit an alternate proposal stating the amount to be added or deducted from the total bid. He is to give full detailed information covering the proposed substitutions, including manufacturers catalogs or description of the article proposed.

PROPOSAL FORM

The following form or proposal must be strictly adhered to in every respect. Any deviation from this form shall be sufficient cause for the rejection of any bid.

Each Contractor and sub-contractor shall give all separate alternate and unit prices requested and shall give lists of all materials upon which he is basing his bid and other information requested.

Lawrence A. Strobel
Engineer
Lansing, Michigan

Gentlemen:

We, the undersigned, propose to furnish all labor, materials, equipment, and services, necessary for the construction and completion of the Electrical Work as called for on the plans and specifications prepared by: Lawrence A. Strobel, Engineer, in accordance with the Instructions to Bidders, Form of Contract, Form of Proposal, General Conditions, Specifications and Engineers drawings for the sum of:

_____($) Dollars

apportioned as follows:

Lighting _____$_____

Power (according to typical Drg E-2) _____$_____

Fixtures _____$_____

We will start work as soon as the progress of the building and other equipment requires and will keep pace at all times with the construction work so as not to delay or interfere with the progress of other trades.

If the Power is installed in a conduit raceway instead of the one specified, according to Alternate No.1 you may deduct the sum of_____($_____) Dollars.

For other makes of material or equipment:

	Make	Type	Add	Deduct
Conduit			$	$
Wire			$	$
Boxes			$	$
Switches			$	$
Receptacles			$	$
Switch & Receptacle Boxes			$	$
Panel Boards			$	$
Duct for Lighting			$	$
Duct for Power			$	$
Safety Switches			$	$

Material or equipment not shown or specified:

Material or Equipment	Description

UNIT PRICES

We further agree to add or deduct any of the following at the price set opposite:

Branch Circuit Run Per Ft. ½" Conduit	$
Power Circuit Run Per Ft. ½" Conduit	$
Switch Outlet Complete	$
Plug Outlet Complete	$
Ceiling Outlet Complete	$
30 Ampere Power Outlet Complete	$
60 Ampere Power Outlet Complete	$
Ceiling Fixture Complete	$

Respectfully Submitted,

Signed _____

Address _____

BY _____

Title _____

F O R M O F C O N T R A C T

_____

_____

Lansing Michigan

with

_____

_____

_____

THIS AGREEMENT, made this ..... day of..... in the year Nineteen Hundred and Thirty, by and between

.....

.....

.....

herein after called the Contractor and the .....

.....

.....

herein after called the Owner.

WITNESSETH, that the Contractor and the Owner in consideration of the agreements hereinafter named, agree as follows:

Article I - Scope of Work The Contractor shall and will provide all materials, facilities, equipment, etc., and perform all work required for the construction of an electrical lighting and power system for the proposed factory building to be erected on the Pere Marquette Railroad Siding in Lansing, County of Ingham, State of Michigan as shown on the drawings E-1 and E, and miscellaneous detailed drawings, and described in the specifications in accordance with the "Instructions to Bidders", "Form of Proposal", "Form of Contract", and "General Conditions" which are hereby declared to be a part of the specifications prepared by Lawrence A. Strobel herein after designated the Engineer, which drawings and "Specifications", "Instructions to Bidders", "Form of Proposal", "Form of Contract", and "General Conditions", the Contractor acknowledges he has received.

(Contract or will here state the acceptance or rejection of the alternates also list of unit prices referred to in the specifications)

Article II - Time of Completion - The work to be performed under this contract shall be commenced as soon as the progress of the building and other equipment requires and will keep pace at all times with the construction work so as not to delay nor interfere with the progress of all other trades.

Should the Contractor become insolvent, or at any time refuse or neglect to supply a sufficiency of properly skilled labor, or of materials of proper quality, or fail in any respect to proceed with the work with promptness and diligence, or fail in the performance of any of the agreements herein contained, such refusal, neglect, or failure being certified by the Engineer, the Owner will be at liberty after fourty-eight hours' written notice to the Contractor to provide any such labor or materials, and to deduct the cost hereof from any money then due or thereafter due to the Contractor under the Contract; and, if the Engineer shall certify that such refusal, neglect or failure is sufficient grounds for such action, the Owner shall also be at liberty to terminate the employment of the Contractor for the said work, and to enter upon the premises and take possession, for the purpose of completing the work included under the contract, of all materials, tools and appliances thereon, and to employ any other person or persons to finish the work, either on a fixed sum contract basis, or percentage basis, or a combination of the two, whichsoever in the opinion of the Engineer shall be advisable and to provide the materials herefore, and in case of such discontinuance of the employment of the Contractor, the Contractor shall not be entitled to receive any

further payment under the contract until the said work shall be wholly finished, at which time, if the unpaid balance of the amount to be paid under the contract shall exceed the expense incurred by the Owner in finishing the work, such excess shall be paid by the Owner to the Contractor, but if such expense shall exceed the unpaid balance the Contractor shall pay the difference to the Owner. The expense incurred by the Owner as herein provided, either for furnishing materials or for finishing the work, and any damage incurred through such default, shall be audited and certified by the Engineer whose certificate thereof shall be conclusive upon the parties.

Article III - The Contract Sum The Owner shall pay the Contractor for the performance of the Contract, subject to additions and deductions provided therein, in current funds as follows: .....

.....

.....

Article IV - Progress Payments The Owner shall make payments on account of the Contract as provided herein, such payments to be made only upon certificates of the Engineer, as follows:

Ninety Percent, of the value of the completed Work, and 75% or the value of materials delivered at the building, both upon estimates made by the Engineer. Such estimates shall not be required to be made by strict measurements, but may be made by estimation.

Article V - Acceptance and Final Payment Final payment shall be due thirty days after completion of the work and acceptance thereof by the Owner. Upon receipt of written notice that the work is ready for final inspection and when the Engineer finds the work acceptable under the Terms of the Contract and the Contract fully performed, he shall promptly issue a final certificate over his own signature, stating that the work provided for in this contract has been completed and has been accepted by him under the terms and conditions thereof. Before issuance of the final certificate the Contractor shall submit an affidavit satisfactory to the Architect that all payrolls, materials, bills, sub-contractors and other indebtedness have been paid. If after the work has been substantially completed, full completion thereof is material delayed through no fault of the Contractor, and the Engineer so certifies, the Owner shall, upon certificate of the Engineer and without terminating the Contract, make payment of the balance due for the portion of the work fully completed and accepted. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

Article VI - Alterations No alterations shall be made in the work except upon the written order of the Engineer approved by the Owner, the amount to be paid to or allowed by the Contractor by virtue of such alterations to be stated in said order.

In Witness Whereof the parties hereto have executed this Agreement, on the day and year first above written.

Witnesses

_____ Contractor

BY_____

_____ Owner

BY_____

GENERAL CONDITIONS
FOR
ELECTRICAL WORK

GENERAL

The building required by this specifications and the accompanying drawings is to be located on the property of the Owner, located at the South East Corner of East Saginaw Street and the Intersection with the Michigan Central and Pere Marquette Railroad Right of Way, at Lansing, Michigan in the County of Ingham.

The work consists of a complete lighting, fixture, and power layout, all as shown on the drawings as mentioned in the specifications.

RAILROAD TRACKS

The Owner has and will maintain a R.R. Siding for the use of all Contractors, Sub-Contractors and Owner and all use of same by any Contractor shall be subject to its use by other Contractors or the Owner.

TELEPHONE

In the office, as directed, there is to be placed by the General Contractor, a city telephone for the use of the Engineers, Architect, Owners Superintendent , and the respective Contractor Superintendents or representatives only. This phone to be used for local calls only, and then for calls only in line with the strict furtherance of the work.

Any long distance calls which may be necessary for the furtherance of this work shall be paid for by the person making such calls and shall be made only with the knowledge of the General Contractor. All service charges on these phones shall be paid for by the General Contractor except as above stated.

TELEPHONE Cont'd

Coin type of phones will not be permitted in Architect's office, but same may be provided for such long distance calls as may be required by other Contractors.

CLEANING

Each Contractor is at all times required to keep the building and premises clean of rubbish caused by the building operations, and is to remove all rubbish as often as directed by the Architect's Superintendant. If the Contractor does not at all times provide a sufficient a number of men to attend to the cleaning immediately upon request the Superintendant may employ such men direct and charge the cost of same to the account of the Contractor. Upon completion of the work the Contractor is to leave all in a neat and clean condition. Each Contractor shall arrange with his sub-contractors the subdivision of the cost of such cleaning.

INCIDENTALS

The Electrical Contractors shall include in their proposal a sum of Five Hundred Dollars ($500.00) for incidentals.

If the total amount of orders issued is less than the above amount the difference is to be deducted from the final payment made to the Contractor.

METHOD OF CARRYING ON WORK AND BARRICADES

The Contractors are to consult with the Building Superintendant as to the methods of carrying on the work so as not to interfere with the Owner's Operations, and all is to be arranged to suit the Owner's requirements.

Each Contractor shall provide all barracades, guards, or such other protection around his work as required for the protection of the public or the Owner's employees and shall assume all responsibility for the same, and keep them in repair. All are to be free from advertising signs excepting those usually placed by the contractors doing the work.

All Contractors are responsible for the complete protection of all of the Owner's property which comes within the boundary of the work being performed in such a manner that when the work is completed it may be left in as good condition as it was before the work was started.

PATCHING AND REPLACING OF DAMAGED WORK

Each Contractor will be held responsible for all damage that is caused by his work or workmen, to plaster, glass, and all other work, patching and replacing or refinishing of damaged work shall be done by the Contractor who installed the work, as directed by the Superintendant but the cost of same shall be paid by the Contractor who was responsible for the damage.

The Mason Contractor will leave all required recesses and do all necessary cutting required by this contractor, but this Contractor shall make all arrangements beyond the point where his work can be done by the Mason Contractor with the least expense, otherwise, all extra necessary expense caused by the negligence of this Contractor in informing the Mason Contractor of such required work shall be borne by this contractor.

LIABILITY INSURANCE

All Contractors shall secure and protect the Owner from any liability or damage whatsoever, for injury to any persons or property and immediately on starting the work shall take out a Public Liability Insurance.

During the continuance of the work under this contract, also extra work in connection therewith, Contractor shall maintain liability insurance in an amount of not less than $25,000.00 for injury to any one person and $100,000.00 for injury to more than one person, to protect themselves from any liability of damage for injury to any person or persons. All Contractors shall also similarly take out and maintain liability insurance to protect them from any liability or damage for injury to any of their employees, including any liability or damage which may arise by virtue of any statute or law now in force or which may hereafter be enacted.

All insurance policies are to be issued by Companies authorized to do business under the law of the State in which the work is to be done and copies of said policies are to be filed, before work is started with the Engineer, if required.

PATENTS

The Contractor shall forever protect and defend the Owner in the full and free use and enjoyment of any and all rights of any invention, machine, or device which may be applied as part of the work either in the construction or use after completion, against all demands of all persons whomsoever.

CHECKING OF CONTRACTOR'S SHOP DRAWINGS

In checking over shop drawings for contractors and the approving of same, the Engineer does not relieve the Contractors from responsibility for errors or omissions which may exist, even though in accordance with approved drawings. Checking of drawings is to be regarded as gratuitously assisting the contractors and the Engineer does not thereby assume responsibility for such errors or omissions. Where such errors or omissions are discovered later, they must accordingly be made good by the Contractor irrespective of any approval thereof.

MOVING MATERIALS

If it becomes necessary at any time during the erection of this building to move materials which are to enter into its construction, which materials having been temporarily placed, the contractor or sub-contractor furnishing said materials shall when directed move same or cause them to be moved at the direction of the Superintendent without additional charge.

ACCELERATION OF WORK

If, in the judgment of the Engineer, it becomes necessary at any time during the erection of this building in order to accelerate the work, each Contractor or Sub-Contractor, when ordered and directed by the Engineer's Superintendent, shall cease work at any particular point and transfer his men to such point or points, and portion of his work as may be required, to enable others to hasten

and properly engage and carry on their work, all as directed by the Engineer's Superintendent.

ENGINEER'S SUPERVISION

The Engineer's Supervision is for the purpose of assuring the Owner that the plans and specifications are being properly executed and while the Engineer's Superintendent in charge is instructed to give the contractor all desired assistance in interpreting the plans and specifications and otherwise, such assistance is not to relieve the contractor from any responsibility for the work. Any work which proves faulty must be made right irrespective of the Engineer's Superintendent.

The fact that the Superintendent has permitted faulty work or work not in accordance with plans and specifications to be done is not to prevent the Engineer from insisting upon making all work right.

OWNER'S OPTIONS

In all cases where the choice of more than one make or style of article or material is specified, the final selection of the article or material rests with the Owner. Where any difference occurs in price such differenèe is to be given before the contracts are signed. After the Contracts have been signed the Owner reserves the right to choose whichever article or material he desires, assuming unless previously advised to the contrary, that the price is not increased thereby. Where the specifications call for any stipulated item (or other equal thereto and approved)

or other words to that effect it is to be taken same as if the choice of more than one material were specified and the selection will rest with Owner same as above.

The Owner reserves the right to let also independently of the Contractors for work herein specified any other work in the building even if of like character and trades.

INSTALLATION OF OWNER'S EQUIPMENT & MACHINERY

The Contractor agrees with the Owner to let the Owner place and install as much equipment and machinery during the progress of the building as is possible before the completion of the various parts of the work and further agrees that such placing and installation of equipment does not in any way evidence the completion of the work or any portion of it, nor signify the Owner's acceptance of the work nor any part of it.

SIGNED PLANS & SPECIFICATIONS

Immediately on signing the contract for the construction of the work, the Contractor is to sign and file with the Engineer's Office a complete set of plans and specifications as additional evidence of his understanding of the work called for, which work is amended as specifically mentioned in the signed contract.

CONTRACTOR'S RESPONSIBILITY

The several contractors (in case of general contract, general contractor assumes entire responsibility) shall be responsible each for his work and every part thereof, and for all materials, tools, appliances, and property of every description used in connection therewith. They shall specifically and distinctly assume and do so assume all risks of damage or injury to any persons or property wherever located, resulting

from any action or operation under the contract or in connection with the work, and undertake and promise to protect and defend the Owner against all claims on account of any such damage or injury.

TIME LIMIT

The work is to be carried to completion with utmost speed. Before signing the contract a definite time schedule shall be prepared by each Contractor to which he shall work and of which he shall immediately furnish the Engineer a copy.

If in the opinion of the Engineer it becomes necessary for maintaining the schedule and for the completion of the building within a specified time, to work after regular hours or on holidays, Contractors mustimmediately do so upon request without additional cost to Owner.

CONTRACTORS' MEETINGS

At regular intervals, as directed by the Engineer's Superintendent, there is to be held at his office a meeting of the representatives of the various trades engaged about the building, for furthering the progress of the work and giving of instructions by the Superintendent. Where representatives fail in attendance or in executing the orders given them they shall on request of the Engineer be dismissed from the work within 12 hours from such request and other representatives must be immediately substituted.

GUARANTEE

Unless otherwise specified under the several headings, all work to be guaranteed for two years after completion of

the building, during which time any imperfections which may develop in the workmanship or materials used are to be made good without cost to the Owner.

Any other work affected in making good such imperfections must also be made good.

CODES AND ORDINANCES

All material, apparatus and its installation shall conform to the "National Electrical Code" as approved by the National Board of Fire Underwriters; the Rules and Regulations of the Department of Buildings and Safety Engineering of the City of Lansing, of the Board of Water & Electric Lt. Commissioners of the City of Lansing and of any other Department having jurisdiction.

Should any change in the plans and specifications be required to comply with the local regulations, the Contractors shall notify the Engineer at the time of submitting his bid. After Entering into contract, the contractor will be held to complete all work necessary to meetin local requirements without extra expense to the Owner.

Where specifications describe or plans show material of higher quality than required by the above ruling, the plans and specifications shall govern quality.

EXAMINATION OF PREMISES

It will be assumed that those tendering proposals shall have made all necessary examination of the premises and shall have satisfied themselves as to the conditions under which the contract is to be carried out should they be awarded same. No allowance will subsequently be made by the Owner due to any

any error or omission on the part of the bidder in this connection.

DRAWINGS TO BE FURNISHED

The Engineer will furnish the Contractor two complete sets of drawings and specifications to scale and also all necessary detailed drawings. Any further copies of drawings or specifications desired by the Contractor will be furnished him for the cost of reproducing the same.

DRAWINGS & SPECIFICATIONS TO BE CO-OPERATIVE

This specification and the accompanying drawings are intended to describe and provide for a finished piece of work. They are intended to be co-operative and what is called for by either shall be complete in every detail, notwithstanding every item necessary involved is not particularly mentioned and the Contractor will be held to provide all labor and materials necessary for the entire completion of the work intended to be described, and shall not avail himself of any manifestly unintentional error or omission should such drawings or specifications, the Contractors, before proceeding with the work shall make mention of the same to the Engineer for proper adjustment and in no case shall they proceed with the work in uncertainty.

Contractor will note that the building is a two story structure with both the first and second floors typical. Contractor shall figure both lighting and power for both floors the same altho plans are shown for but one floor. All other necessary requirements shall be met as shown on these typical plans and riser diagrams.

The Contractor shall submit unit prices on work to govern both additions to and deductions from the contract as hereinbefore provided.

These prices are to be such that they meet with the Engineer's approval and are to be the same for both additions and deductions.

BILLS FOR EXTRAS

Bills for extras or additional work must be submitted to the Engineer in writing within 48 hours, or on demand after work authorized has been completed. Contractor must make estimates of any additional work which is proposed by the Engineer on request, and extras resulting from the approval of such proposals shall be in the amount of such proposals. Bills for extras must be approved by the Engineer or Owner before such additional work is executed. No payment on such bills will be made before final settlement unless otherwise agreed upon.

QUALITY OF MATERIAL AND WORKMANSHIP

Should any dispute arise as to the quality of fitness of material or workmanship, the decision shall rest strictly with the Engineer, and shall be based on the requirements that all work done or materials furnished shall be first-class in every respect, and what is usual and customary in erecting other buildings shall in no wise enter into any consideration or decision whatsoever.

REMOVAL OF UNFIT MATERIALS

All materials or workmanship of unsound or unfit character or work, or materials which may become damaged after they are in place in the building shall be immediately removed, re-

constructed or refinished by the Contractors to the satisfaction of the Engineer, upon proper notice. The expense of doing so or cost of delays and of making good other work affected by the changes shall be borne by the Contractor in fault, and no extension of time will be allowed for the correcting of faulty work.

COMPLETION OF WORK

All conditions as required under completion of work shall be as enumerated or written in the contract form under Article II, Paragraph 2.

SAMPLES TO BE SUBMITTED

The Contractor shall furnish to the Architect, at his office and for his approval, when requested, samples of all materials to be used in the execution of the work herein described, of the finish to be given to the several parts. All materials furnished must be fully equal to the approved samples.

DELAYS ON ACCOUNT OF BAD WEATHER OR OTHER CAUSE

The Contractor shall take the whole responsibility of the work, and should any unforeseen difficulty arise from bad weather or from any other cause, except as otherwise provided herein, involving a greater expenditure of money than the Contractor expected at the time of bidding, he must proceed with the remainder of the work and no allowance will be made for any such casualty.

EXTENSION OF TIME

The Owner is not to be held responsible for any damage incurred by the Contractor through the fault of any other contractor employed by the Owner. Should the Contractor be

delayed in the prosecution of the work by reason of the above cause, or through the Owner, the time of completion shall be extended for a period equivalent to the time lost, which period shall be determined by the Architect, but no such allowance shall be made unless a claim therefor is presented in writing to the Architect with forty-eight hours of the occurrence of such delay.

SUB-LETTING OF CONTRACT

The Contractor shall not assign or sub-let the whole of any part of this work without the written consent of the Architect approving the specific party to whom it is proposed to sub-let the same.

CONTRACTOR RESPONSIBLE FOR PROMPTNESS OF EXECUTION

It is not incumbent upon the Architect to notify the Contractor when to begin, to cease, or resume work, to to give early notice of the rejection of faulty work, nor in any way to superintend so as to relieve the Contractor of responsibility or of any consequence of neglect or carelessness by him or his subordinates. All materials and labor shall be furnished at such times as shall be for the best interests of all contractors concerned, to the end that the combined work of all may be properly and fully completed on contract time.

However, any employee of any contractor whom the Engineer considers detrimental to the proper carrying out of the work is to be removed promptly on the request of the Engineer.

CERTIFICATES FOR PAYMENT

Certificates for payment are to be issued by the Architect in accordance with the terms of the contracts.

In case of the delivery of materials, or prepared work which cannot be conveniently fixed in place the Architect may, if he approves of what has been done, grant a certificate of payment on account of the same which payment shall be recjibed one of the payments on account of the contract.

All materials necessary to the construction of the building delivered upon the premises shall be held to be the property of the Owner and no materials shall be removed from the premises without the written consent of the Engineer.

No certificate shall be issued in favor of the Contractor for material not delivered upon the premises.

No certificates given or payments made under the contract, nor the occupancy of the building, either partial or entire, by the Owner, shall be conclusive evidence of the performance of the contract, either wholly or in part, and no payment shall be construed to be an acceptance of defective work or improper materials. No payment of certificates final or otherwise shall be construed to relieve the Contractor from obligation to make good any defects arising or discovered in his work within two years after completion and acceptance of the same, nor as a waiver of any specific obligation the Contractor may assume as to the durability of his work.

The Engineer shall have the power to withold certificate for payment if in his opinion the work is not being done or

progressing satisfactorily, until such time as the progress or character of the work have been, in his opinion, satisfactory.

Before the issuing of each certificate for payment the Contractor shall, if required by the Engineer, furnish him with a sworn complete statement of the amounts due or to become due at the time of the application for the certificate in question, to any Sub-Contractors or parties supplying material.

FIRE INSURANCE

The Owner and Contractor shall each protect their own interests against loss by fire. The Contractor's interest shall consist of all labor and materials which he may have put into the building, the material delivered on site and for which he has not been paid, and the Owner's interest shall consist of all labor and materials in the building and material delivered on site for which he shall have paid and to this extent only.

Any other insurance will be carried by the Owner.

ELECTRIC WIRING SYSTEM

INDEX

NATURE OF INSTALLATION

This installation shall be complete in every detail even though each and every petty item necessary be not specifically mentioned herein or shown on drawing.

In generator, this system shall consist of main service connection, main distributing panel, branch power and lighting feeders, branch distributing panels, branch lighting circuits, outlet boxes, switches, fixtures, etc., all as hereinafter specified. The Owner will furnish to the building the energy for this power and lighting system. Power will be 440 Volt, three wire, three phase, 60 cycle, service and 120/240 Volt, three wire, single phase, 60 cycle service for light. The Contractor shall connect to this service furnished by the Owner at the point designated on the plans. The system of wiring for lighting shall be that known as the "Conduit System". All mains, branch mains, branch lighting circuits, etc. in connection with the lighting system shall be run in approved Hot-Galvanized Conduit. All wires of the same circuit shall be run in the same conduit. All conduit shall be ¾" or larger, and no conduit ½" shall be allowed in the building unless otherwise specifically stated or approved in writing. Circuits shall be carried home in 2½ x 2½" square "Pro-Duct" as manufactured by Bull Dog Mutual Electric Supply of Detroit, Michigan, all as shown on the plans. Feeders to main distributing panels (both power and light), sub-distributing panels, branch lighting, and branch power panels shall be run in similar "Pro-Duct" of sufficient size, as shown on riser diagrams, and on the plans. All lighting conduits shall

be run exposed as shown on the plans and all lighting so run shall be square with the building.

All wires run underground in ground floors, also all wires in slabs which form a portion of the roof with no air space above shall be lead covered. Wire to be as specified under the heading of "Wire".

WORKING DRAWINGS

Contractor shall submit to the Engineer for his approval, before starting any work, working drawings showing a complete layout of all work as he contemplates doing it. The Engineer will promptly correct or approve such drawings and the Contractor shall make corrections as indicated and return the corrected tracings upon which the Engineer will place his stamp of approval.

After the work is completed the Contractor shall make any further corrections or additions as executed and furnish the Engineer three copies of the corrected prints made from such corrected tracings at the time he makes his request for final payment.

CONDUIT

Size of conduit shall be strictly in accordance with the standard adopted by the National Electrical code. All wires in outlets on plastered walls and finished ceilings shall be installed before finished plaster coat is put on. In all cases conduit for switch legs, plugs, brackets, or key wall outlets where shown in concrete columns or concrete walls shall be concealed.

Where conduits run exposed approved condulet type of fittings or outlet boxes shall be used at all bends in a

verticle plane, or where breaking around columns or beams, bends on ceiling and horizontal planes may be made with long sweep ells. Approved Condulet type of fittings or outlet boxes shall be installed at all outlets. All conduit shall be securely fastened in an approved manner. All conduit shall be Galvanized and of an approved rigid type.

All conduit shall be carefully reamed after the threads are cut and before installing, and coupled so as to be water tight. At ends of all conduit the Contractor shall provide approved tinned iron bushings for the protection of wire against the edge of conduit, and where ends of conduit enter outlet boxes, etc. they shall be securely fastened in and approved manner.

Where necessary to run conduit in plastered brick walls the walls shall be channeled out to a sufficient depth to receive the conduit which shall be fastened in place, covered with metal lathe and filled around with cement.

Where switch or light outlets occur in unplastered brick walls the conduit shall be put in place before brick work is erected and brick work built around same.

Where necessary to run conduits in concrete or fire-proofing conduits shall be installed before the concrete or fire-proofing is put in place.

As far as possible, all conduit shall be kept clear of cinder concrete fill. Where necessary to run conduit in cinder concrete same shall be well protected with sand and cement concrete to avoid any possibility of cinders coming in

contact with conduit.

OUTLETS

All outlets except where otherwise specified shall consist of approved Galvanized steel outlet boxes of pattern adapted to the special requirements of each outlet, securely fastened in place in an approved manner.

Bracket and ceiling outlet boxes shall be provided with four prong fixture studs, hexagonal outlet boxes shall be used.

For receptacle outlets, Contractor shall provide steel outlet boxes of proper pattern approximately 4 inches square equipped with single or double gang plaster rings where bedded in concrete. Where necessary to run exposed, Contractor shall furnish approved FS condulet boxes. These are to be equipped with approved duplex convenience outlets or 15 ampere heavy duty type and approved covers.

For receptacle outlets on outside of building Contractor shall furnish weather-proof receptacles equal to R. & S. #123.

SWITCHES

All knife switches used throughout shall be single break knife switches of G.E., Trumbull Electric, Frank Adam, or Mutual Electric manufacture.

All switches controlling individual lights of individual lighting circuits (except as otherwise specified for cabinets) shall be G.E. or Bryant, toggle type with square handles and composition bases, same to be equipped with approved type industrial covers.

FUSES

Edison plug fuse shall be used in branch lighting circuits and Economy renewable cartridge tubular or approved equal standard make shall be used in all power circuits and in power and lighting feeders. Contractor shall replace all fuses blown up to the time of acceptance of the work.

Extra fuses shall be provided as indicated under the heading "Specific Data".

WIRE

The wire used throughout shall not be less than No.12 rubber covered, "Intermediate" grade N.E.C. standard for 600 Volt service, insulated with 30% para by weight. Wires No.8 or larger shall be double braid, stranded wire, No.12 and No.10 may be single braid. Wire to be as manufactured by General Electric or Habirshaw Cable & Wire Corp.

BRANCH LIGHTING DISTRIBUTING CABINETS & PANELS

Branch lighting distributing cabinets shall be sectionalized dead front, one plug fuse holder for each branch circuit connection with 30 ampere single pole, toggle switches in the branches with lug only in the mains.

These distributing cabinets to be surface mounting, made of No.10 guage steel with steel trim and steel doors. To be door in door construction, door to be hinged, made to close tightly and provided with catch and yale lock. Cabinets to be galvanized. All panels to be keyed alike.

Panels to have capacities as given under the heading "Specific Data" or as shown on the Riser Diagram.

All circuits to be balanced on the three wire mains.

SWITCHBOARD

Contractor shall furnish and install where shown on the plans a dead front Saf-Te-Fuse totally enclosed switchboard to accommodate all lighting and power, all as manufactured by the Mutual Electric Company of Detroit, Bull Dog, or approved equal.

BUS-DUCT INSTALLATION FOR POWER

Contractor shall install where shown on the plans 4 lines of "Bus-Duct" with plug receptacles spaced on 40" centers and with provisions for installing receptacles on 20" centers.

The capacity of the lines shall be 600 ampere half the length of the building tapering to 300 ampere the rest of the length of the building, same to be totally enclosed and insulated by horn fibre tubing throughout their entire length. In joining sections of Bus-Duct together, one end of the bus bar shall terminate in a jaw with a clamping bolt and nut through it. The slotted end of the adjoining bus bar shall fit over this clamping bolt and between the jaw and the two sections then clamped together by tightening a nut from the top with a wrench which shall be furnished. Fibre tubes shall then be slipped over the whole joint which shall be held in place by raw hide pins, completing the insulation of the Bus-Bar throughout its entire length.

Receptacles shall be made of genuine molded bakelite built up of sections designed to permit of their being assembled on or detached from the Bus-Bars after the Bus-Duct is installed.

Fusible switch plugs shall consist of bakelite housing with aluminum casting of either end which protects and completes the plug. Cartridge fuses shall be accessible through a window in the bakelite housing which may be removed opposite any fuse. Any interlocking mechanism shall make it impossible to replace fuses without first disconnecting the plug from the Bus-Duct. The contact shall be made with the Bus-Bars by the three three blades imbedded in one end of the Bakelite housing, these blades fitting into the contact fingers of the receptacles in the Bus-Duct. The aluminum casting shall protect the blades at all times and serve as a ground in co-operation with a locking device on the retaining plate of the receptacles, as a means of clamping the plugs quickly and securely in place on the Bus-Duct. The other end of the plug shall contain wire terminals of cable lugs covered by the casting to which can be attached a flexible cable for connection to each machine.

Contractor shall include in his estimate the connection of all machines by this manner, <u>and so arrange his work that all equipment will be permanently and effectually grounded.</u>

Contractor shall furnish and install Fusible Switch Plugs for NEC enclosed renewable fuses of the following quantities or capacities.

400 - 30 Amp. 600 Volt 7½ HP & under
55 - 60 Amp. 600 Volt 10 HP, 15 HP, & 20 HP
4 -100 Amp. 600 Volt 25 HP, 30 HP, & 35 HP
1 -200 Amp. 600 Volt 40 HP to 75 HP incl.

The above plugs shall be so arranged that grounding is automatically accomplished when the plugs are inserted in the receptacles, and so keyed to the Duct that when a plug is once connected to a machine or motor the latter will always run in the correct rotation whereever connected to the Duct. (All four Duct to be similarly phased).

Contractor to furnish all necessary hangers, ells, closure plates, receptacles, and plugs (as above specified) to make the installation complete in every detail and rigidly and securely fastened in a first class manner.

BUSSING

Connection between the Bus and the Switchboard shall be made by buss which shall be enclosed in transite board duct securely fastened in place by angle iron. All Bus-Bars shall be figured 1000 amperes/sq. inch.

FEEDERS

All other feeders for lighting and power shall be run in conduit as specified above and rigidly fastened with ring hangers or on an approved pipe rack. Hangers shall be fastened by means of inserts placed in the Concrete construction before the concrete is boured in place.

SERVICE

Service to the switchboard will be furnished by the Owners from an outside sub-station under another contract.

FIXTURES

Contractor shall furnish and install at each ceiling outlet Benjamin No.7202 Glassteel Diffuser, ½" pipe stem (Galvanized) and Benjamin No.3380 Ball Aligner 4" outlet box cover, or approved equal so arranged that the reflector, lamp, and globe may be taken down as a complete unit for easy cleaning

on the floor. Each of the above fixtures to be equipped with 300 Watt, Type C, Edison Mazda, National Mazda or Westinghouse Mazda Lamps 125 Volt.

In toilets and elevator, and similar locations furnish and install RLM Dome Reflectors with similar features as above, 100 Watt to be Benjamin No.7182, 150 Watt to be No. 7184, 200 Watt to be Benjamin No.7188 each equipped with fixtures stem, Ball Aligner and lamps as above.

Brackets on the outside of the building shall be furnished with Benjamin No.5040 Goose-Neck, No.7188 R.L.M. reflector and 300 Watt lamp all as specified above.

All the above fixtures to be furnished with shock proof sockets.

EMPTY TELEPHONE CONDUIT

Contractor shall furnish empty telephone conduit system in accordance with the requirements of the telephone company. Conduit and outlets to be as specified above. No conduit shall be smaller than 3/4". Outlets shall consist of a 4-5/8" x 4-5/8" box 1½" deep, equipped with suitable ring and a single gang telephone plate.

ALTERNATE NO.1

Contractor shall state in his proposal the amount which he will deduct if all the Bus-Duct installation is omitted and in its place a rigid galvanized power installation is furnished including the necessary panel boards, feeders, wire, connection of approximately 480 machines of an average of 5 HP each, machines will be furnished and set in place complete

by the Owners including all necessary starting devices, motors, and safety switches, except the elevator which will be 40 HP, Contractor to furnish a 200 Ampere, 500 V, TP ST Type A, Safety Switch as manufactured by Bull Dog of Trumbull Electric Company for this service.

POWER PANELS

Contractor shall furnish and install in event that the Bus-Duct system is omitted: branch power distributing panels as shown on the plans.

Panels to be equal to Bull Dog Unit-Versal Saf-to-Fuse convertible sectionalized panels.

Cabinets to be surface mounting and of the description as given above under lighting panels.

Both Power and Lighting Panels to be of the same manufacture and to be all keyed alike.

Panels to be of Capacities as given under the heading "Specific Data".

"SPECIFIC DATA"

SECONDARY SWITCHBOARD

Contractor shall furnish and install a dead front Secondary Switchboard which shall contain the following fused safety switches for lighting.

1800 Amp. 125/250 Volt Main (Lugs only)

4 - 400 Amp. TP ST SN FU Branches

2 - 200 Amp. TP ST SN FU Branches (For spares)

Switches shall be so arranged that they can be locked in either position and that the fuses cannot be removed when the switch is in the closed position.

Contractor shall furnish for power:

6 - 600 Amp. 500 Volt, three pole, O.C.B. Br. including two spares for future lines.

Each branch controlling one line of Bus-Duct.

The board shall be equal in every respect and grade to that as manufactured by Bull Dog, Mutual Electric.

POWER DISTRIBUTING BRANCH PANELS (Alternate No.1)

In the event that Alternate No.1 is accepted contractor shall furnish and erect where shown on typical sheet E-2

20 - Dead front Saf-to-Fuse Bull Dog or approved equal, Sectionalized Convertible Power Panels with each with:

600 Ampere, 500 Volt Mains (Lugs only in mains)

20 Circuit 30/60 Amp. 500 Volt Branches

3 Circuit 60/100 " " " "

1 Circuit 100/200 " " " "

BRANCH LIGHTING DISTRIBUTING PANELS

PANELS A, B, F, & G SHALL be equipped with:

300 Ampere mains lugs only

24 Cir. Switch & Fuse (1 plug cir.)

PANELS C, D, E, H, J, & K shall be equipped with:

400 Ampere mains lugs only

24 Cir. Switch & Fuse (1 plug cir.)

MAIN SERVICE CONNECTIONS

By others. Not in this Contract.

SWITCH HOUSE & EQUIPMENT, SWITCH GEAR, ETC.

By others. Not in this Contract.

TRANSFORMERS AND TRANSFORMER PLATFORM ETC.

By others. Not in this Contract.

SUMMARY

As a summary, I shall give my reasons for the recommendations which I have made in this thesis.

LIGHTING

In Lighting I have based my recommendations as regards the intensity on a common practice with the units spaced on 13 ft. centers and 13 feet from the floor of 13 ft. candles. This is obtained by using a 300 Watt, Type C, Mazda lamp. This will give the proper illumination recommended for a factory of this type. The units recommended were selected because of their freedom from direct and reflected glare, harsh shadows, and sharp contrasts. Because of the special feature of their holder the entire unit can be easily removed by one man for cleaning. Feeder sizes for lighting are based on the use of a 500 Watt lamp in place of the 300 Watt and with each plug carrying a load of 250 Watts with all lamps burning.

POWER

My selection of the Bus-DUCT system is based on the fact that in the modern manufacturing plant it very often becomes necessary to move a machine from one location to another in a short space of time and place it as quickly as possible in order that the work done by that unit will not hold up the entire production. Such a system reduces the loss of time due to such a change to the actual time required to move the machine from place to place. In this connection it is pertinent to mention that it is common practice in the automotive industry to move an entire department during one night and have it ready for produc-

tion again the next morning. This could not be possible with any other system of wiring nor with any other drive than the individual drive.

With the Conduit system it would take no less than two hours lost time per machine for wiring and from that up to weeks if the plant had reached a point where the entire power distribution system would have to be revamped.

The difference in the cost of the two systems of wiring installed in this building would be:

Cost of Bus-DUCT installation	$20,000.00	
Cost of Conduit installation	$11,000.00	$9,000.00

Which amount would be more than compensated by lost time and the resulting overhead charges for dead floor space, interest, and depreciation, taxes and the probable decrease in production due to the weakening on one integral link in the production chain. Figuring all the above on the 10 year replacement basis which is a good average of the life of a production building, and based on a complete change of at least once each year the Bus-DUCTs system would pay for itself five times over in the life of a building, if we neglected interest charges on the additional investment of $9,000.00. This, of course, could not be neglected but the saving is apparently in favor of the more flexible system.

BASIS OF LAYOUT

Since installations for power vary from year to year as explained above and also vary for each particular type of manufacturing industry it would be impossible to lay out a typical installation or representative layout.

For that reason I made certain assumptions based on the average automotive power requirements in an effort to arrive at a basis for an average requirement.

I assumed therefore that the power demand would be at the rate of 1 HP per foot per side assuming that the machines would be spaced along each side and since there were two rows of machines there would be required two lines of Bus-DUCT. Next I assumed that the average machine would be equipped with a 5 HP motor. Since the building is 500 ft. long there would be a required HP per line of Duct of 600 HP. This requires 120 machine connections per line of 480 connections in the two story building having two lines per floor. It was also assumed that the load would be symmetrical about the e center line of the building so that it would only be necessary to run full HP line capacity to the center of the building. Bus-DUCT comes in two convenient sizes of 300 and 600 Ampere so that it was found advisable to use the 600 Ampere size on each line to the half way point, tapering there to the 300 Amp. size.

This should be fed direct from the switchboard which would cause the installation of 4 feeders to fan out to the four ducts on the switchboard end of the building. These feeders can advantageously be Bus-Bar and should be carried in an insulated casing as specified.

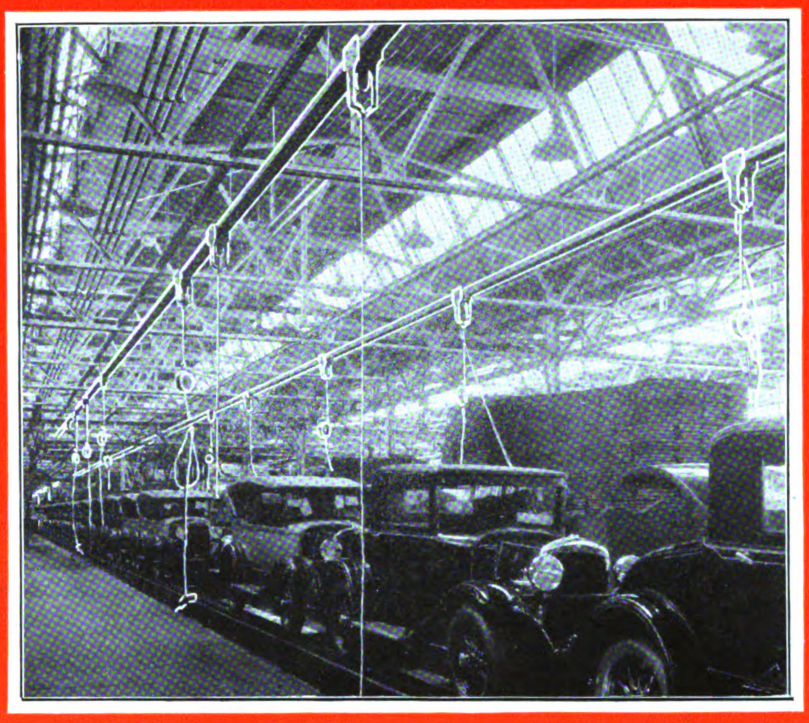
CONCLUSION

BULL DOG AMD SYSTEMS

APPARATUS FOR MASS PRODUCTION

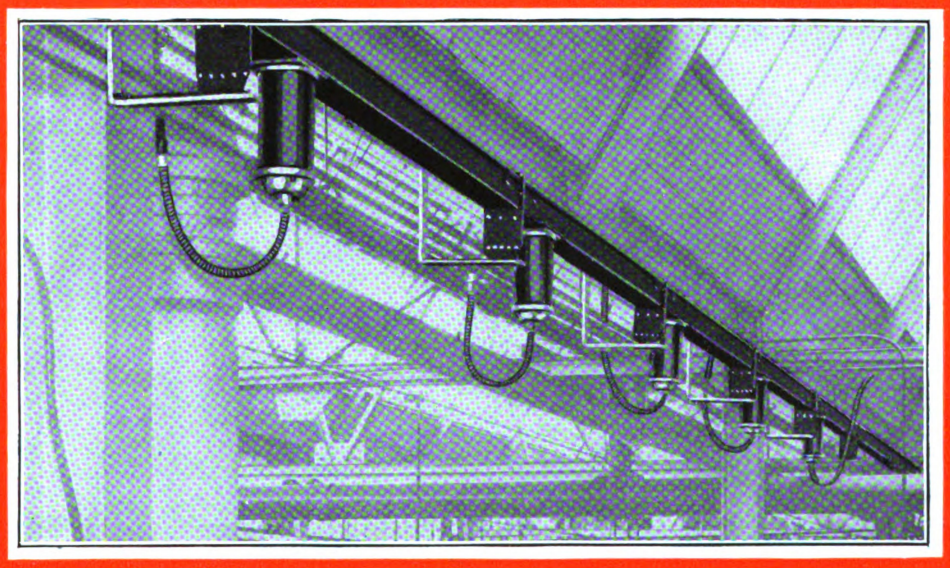
Patents Applied for

Trolley-DUCT



Pro-DUCT

Bus-DUCT



BULLDOG ELECTRIC PRODUCTS CO.

DETROIT MICH. U.S.A.

Apparatus and Systems described herein fully protected by Patents and Patents Pending

A. I. A. File No. 31-C-62

Bus-DUCT

Construction Details and Application of Bus-DUCT, Plug Receptacles and Fusible Switch Plugs

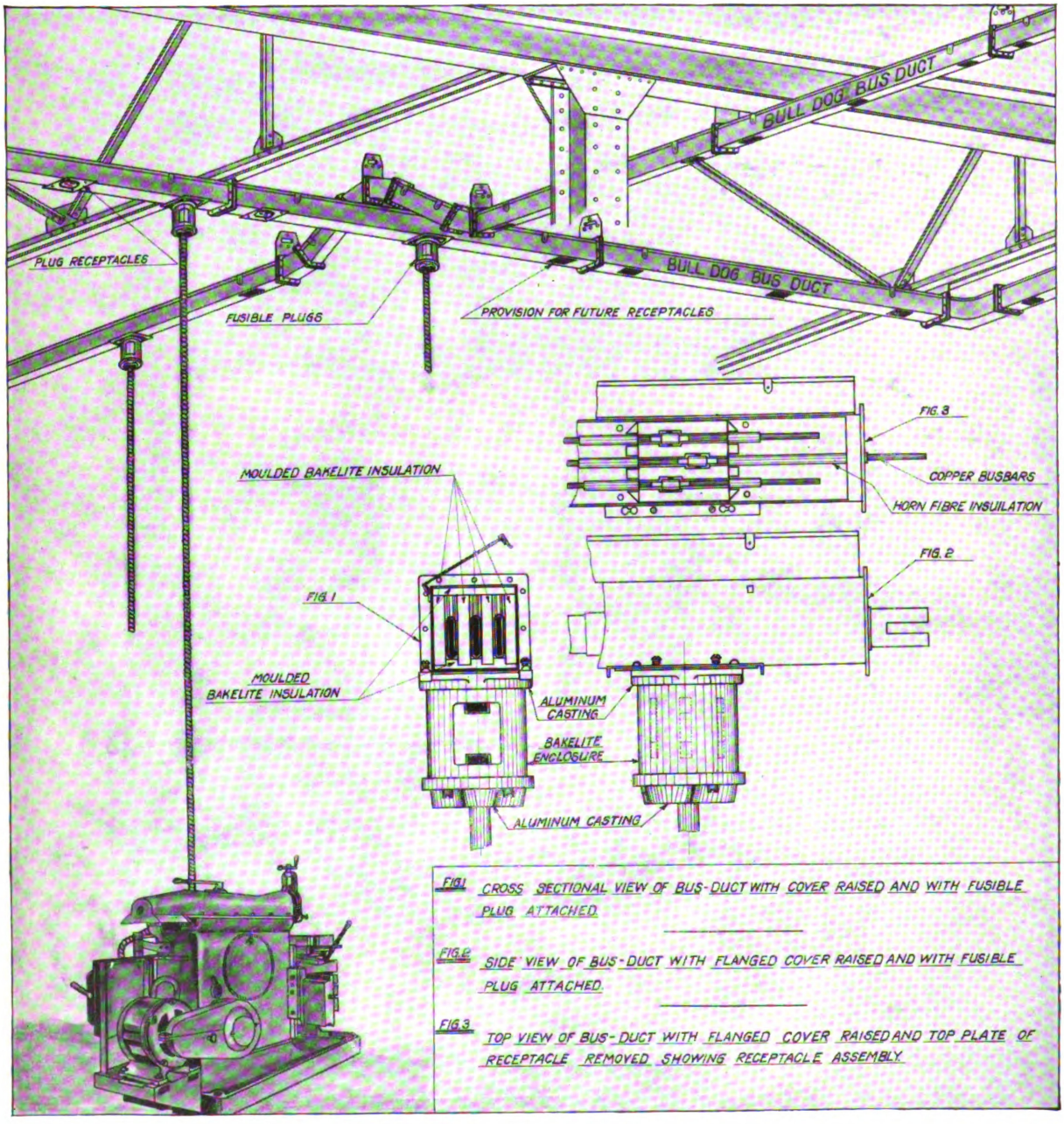


FIG. 1 CROSS SECTIONAL VIEW OF BUS-DUCT WITH COVER RAISED AND WITH FUSIBLE PLUG ATTACHED.

FIG. 2 SIDE VIEW OF BUS-DUCT WITH FLANGED COVER RAISED AND WITH FUSIBLE PLUG ATTACHED.

FIG. 3 TOP VIEW OF BUS-DUCT WITH FLANGED COVER RAISED AND TOP PLATE OF RECEPTACLE REMOVED SHOWING RECEPTACLE ASSEMBLY.

Bus-DUCT and Trolley-DUCT

The spirit of adventure in departing from long established methods of Manufacture, resulting in the creation of Mass Production Methods, has probably thrived greater in Detroit than in any other city.

Bull Dog Electric Products Company has therefore been advantageously situated to watch the development of Mass Production Methods in Industry and to co-operate with Industrial Engineers in designing and producing Electrical Controlling and Distributing Apparatus to fit the new requirements.

And as a result, the following Units or Systems have been designed by BULL DOG who can now offer the most complete Line of Electric Power and Light Controlling and Distributing Apparatus available.

(1) Bull Dog Trolley-DUCT—a flexible system of Electric Control for portable electric tools as used on moving assembly lines in Automobile and other Mass Production Plants.

(2) Bull Dog Bus-DUCT — a Bus Bar system of Electric Power Distribution for Industrial Plants employing Mass Production Methods, where frequent and rapid changes in location of machines, motors and sometimes whole Departments are desired on short notice.

The Bull Dog Bus-DUCT system of Electrical Distribution displaces to some extent, for specific applications, the older method of Distribution by Conduit, Wires and Power Panels.

Bull Dog Bus-DUCT has the following advantages over similar methods of electrical distribution:

1. GREATER ACCESSIBILITY for changes and maintenance because of the hinged cover and unit construction of the enclosing DUCT.
2. GREATER SAFETY. Bus Bars are readily accessible yet completely insulated throughout their entire length. Fusible Plugs are arranged for Enclosed Cartridge Fuses. Complete system positively grounded.
3. GREATER FLEXIBILITY. Plug Receptacles can be added or changed in a minimum of time and with the greatest facility.
4. EASIER INSTALLED and MAINTAINED. Method of joining sections of Bus-DUCT makes for rapid assembly and perfect alignment of Bus Bars and Duct. 350 feet of Bus-DUCT have been assembled and hung up by two men in eight hours.

The advantages of Bus-DUCT with its greater mobility and flexibility may make the initial cost appear somewhat higher than the older conventional methods of electric distribution. Its application therefore is specific and its adoption by individual Plants will depend upon the character of their manufacturing processes and whether such involve frequent changes in location of motors and machines. In the latter case, Bull Dog Bus-DUCT will prove the most economical in time and material saved and in obviating the necessity for temporary wiring during the changing period.

Other BULL DOG Systems

For Industrial Plants whose manufacturing processes are of a more permanent nature with less shifting of machines or departments, a Distribution System combining SAFtoFUSE Feeder Panels with pro-DUCT (wiring troughs and fittings) as described on page 14 would probably prove a more economical installation or the Bus-DUCT system may be used only in such Departments of a Plant where frequent changes are made.

An analysis of the Plant conditions should be made and the best adapted system specified. To this end our Engineering Service Department is available for consultation purposes without obligation to inquirers.

Bus-DUCT

Purpose of System

Bull Dog Bus-DUCT is a Bus Bar system of Electric Power Distribution direct to Motors or Machines, thus supplanting wires, conduit and distributing panels.

The Bull Dog Bus-DUCT system of Electrical Distribution was specially designed for and is most economically adapted to Factories employing Mass Production methods of manufacture resulting in frequent shifting of machine and motor locations to meet production schedules. The rigid permanent nature of the "wires-conduit-panels" method of electrical distribution has proved too costly in loss of time and materials, in making the quick changes necessitated by Mass Production Methods whereas the Bull Dog Bus-DUCT system of Electrical Distribution makes Power instantly accessible in all parts of the Plant and motors and machines can be quickly moved from place to place and "plugged in" to the source of Power, without the necessity of temporary wiring or loss of time or materials.

General Design

Bull Dog Bus-DUCT consists essentially of Bus Bars properly insulated, installed in a metal trough or DUCT having bakelite receptacles connected to the Bus Bars provided at regular intervals of space throughout the the length of the Bus-DUCT for the reception of Fusible Switch Plugs which in turn are connected to the motor or machine they control by flexible cable. When a machine's location is changed the Fusible Switch Plug goes with it and is "plugged in" to a receptacle in the Bus-DUCT at the machine's new location.

Construction Details

Bus-DUCT is furnished in standard lengths of 10 feet, with a Plug Receptacle on 40″ centers but with provisions for installing Receptacles on 20″ centers. The enclosing metal trough or DUCT proper is the same size as Bull Dog pro-DUCT (for wires) and is equally complete as regards Ells, Tees and other fittings to meet any requirement of installation.

BUS BARS are made standard in 300 Amp. and 600 Amp. capacity and are totally enclosed and insulated by horn fibre tubing throughout their entire length. In joining sections of Bus-DUCT together, one end of Bus Bar terminates in a jaw with a clamping bolt and nut through it. The slotted end of the adjoining Bus Bar fits over this clamping bolt and between the jaw and the two sections are then clamped together by tightening the nut from the top with a wrench which we furnish or it may be readily tightened with screw driver and hammer. This method of joining allows certain variations to compensate for conditions of installation, expansion and contraction. Fibre tubes slipped over the whole joint and held in place by raw hide pins complete the insulation of the Bus Bar throughout their entire length.

RECEPTACLES are made of genuine molded bakelite built up of sections designed to permit of their being assembled on or detached from the Bus Bars after the Bus-DUCT is installed.

The component parts of the Receptacles, as shown on Page 6 consists of three copper contact fingers, a bottom section, four spacer sections which are inserted between the Bus Bars and the DUCT and a top cover section all held in place by a steel cover fastened on four studs.

To install a Receptacle in one of the spaces provided in the Bus-DUCT, remove the cover plate over the rectangular hole in the underside of the Bus-DUCT, insert the bottom of the Receptacle, hold this in place with the steel bottom plate which also provides means for holding the Fusible Plug in place, assemble the three contact fingers on the Bus Bars clamping them by means of a screw from the top, insert the four sections for insulating the Bus Bars and the top piece, clamping the whole receptacle assembly together by means of the steel plate held in place by four studs. It will be readily seen from this description that it is just as easy to replace or repair any part of the Receptacle.

FUSIBLE SWITCH PLUGS are furnished in standard sizes with Cartridge Fuse Connections for 30-60-100-200 Amp., 250 Volts and 30-60-100-200 Amp., 600 Volts.

These plugs consist of a bakelite housing with an aluminum casting at either end which protects and completes the Plug. Cartridge Fuses are accessible through a window in the bakelite housing which may be revolved opposite any fuse. An interlocking mechanism makes it impossible to replace Fuses without first disconnecting the Plug from the Bus-DUCT.

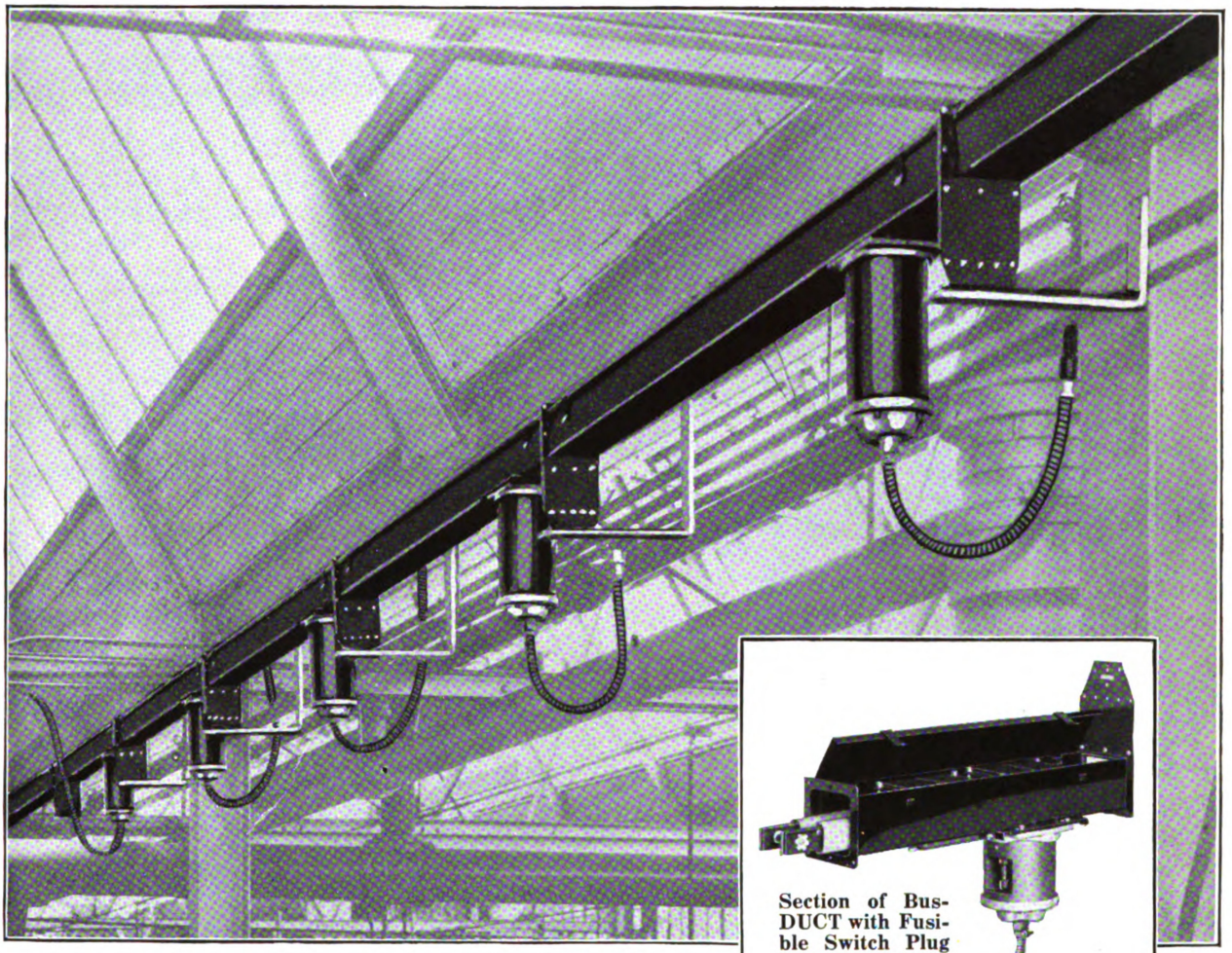
Contact is made with the Bus Bars by three Blades imbedded in one end of the bakelite housing, these Blades fitting into the contact fingers of the Receptacles in the Bus-DUCT. An aluminum casting protects the Blades at all times. It also serves as a ground and, in co-operation with a locking device on the retaining plate of the Receptacles, as a means of clamping the Plugs quickly and securely in place on the Bus-DUCT.

The other end of the Plug contains wire terminals or cable lugs covered by an aluminum casting which is drilled on the job for flexible conduit or porcelain bushing for bringing out the cables to the Motor, as may be desired.

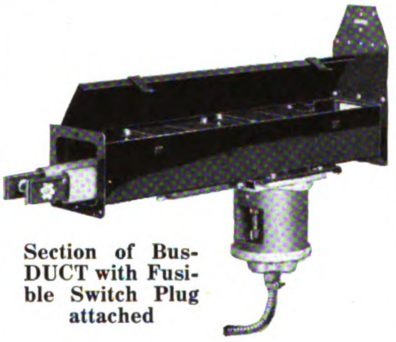
SYSTEM GROUNDED AND POLARIZED. Grounding is automatically accomplished when the Plugs are inserted in the Receptacles by means of the metal parts on the Plugs whereby the latter are clamped on to the Duct. The Receptacles are in turn keyed to the Duct so that they may be placed in only one position. Hence the system is always polarized and once a Plug is connected to a motor, the latter will always run in correct rotation.

Bus-DUCT may be fed from the ends but can be made to fit special conditions of installation with tap-offs in any section of the Bus-DUCT as illustrated on page 7.

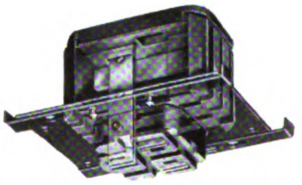
Bus-DUCT



Installation in Graham Bros. Plant, Evansville, Ind.
Division of Chrysler Corporation



Section of Bus-DUCT with Fusible Switch Plug attached



Phantom view of bakelite Receptacle showing Bus Bars and contacts into which Fusible Plug fits.

View of Fusible SwitchPlugshowing the Blades.

Bus-DUCT consisting of insulated Bus Bars installed in 3½″ x 3½″ DUCT is furnished in standard lengths of 10 feet.

Receptacles. Standard Bus-DUCT includes a bakelite Receptacle every 40 inches with provisions for receptacles on 20-inch centers.

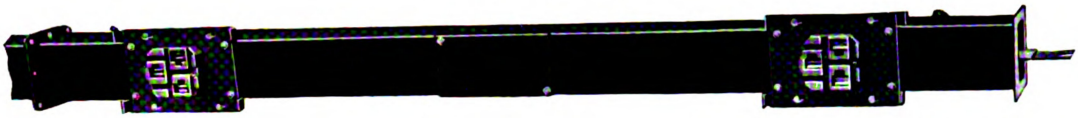
Fusible Switch Plugs for NEC enclosed fuses of the following capacities:

30-60-100-200 Amp. 250 Volt. 30-60-100-200 Amp. 600 Volt.

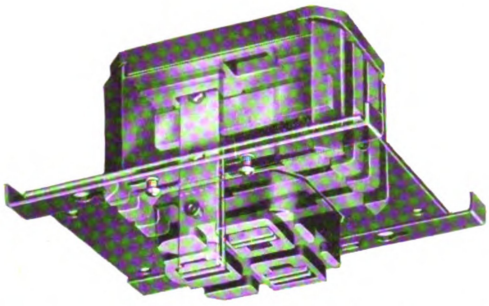
The Bull Dog Bus-DUCT system is based not so much on one large central Power Distribution Unit but rather on a group of smaller Units. This provides a less cumbersome system, more easily installed and maintained and any possible trouble is localized to a section only and does not affect the entire plant.

Prices are not necessarily based on so much a lineal foot but rather on a system complete with all fittings to insure a proper installation best adapted to the particular Plant conditions.

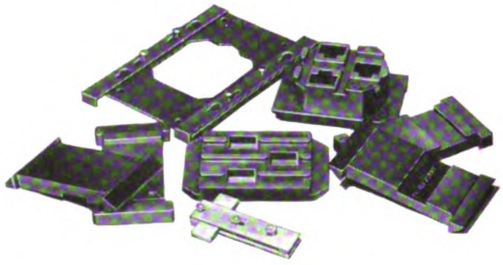
Bus-DUCT



Underside view of half section of a standard 10 ft. length of Bus-DUCT showing Plug Receptacles on 40″ centers but with provision for installing additional Receptacles on 20″ centers by removing the cover plate over the rectangular opening in the DUCT.

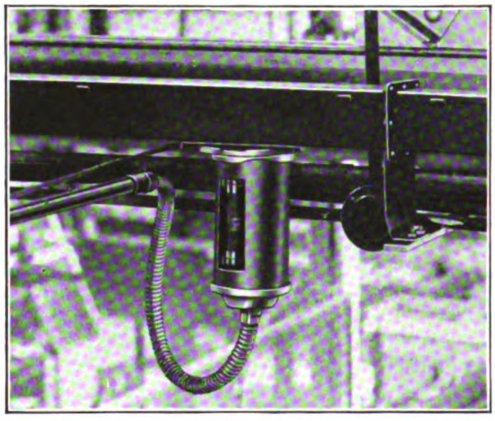


Phantom view of a bakelite Receptacle showing the 3 phase Bus Bars with the copper contact fingers installed thereon, into which the Blades of the Fusible Plug fit.



Component parts of the bakelite Plug Receptacles consisting of three sets of copper contact fingers, a bottom section, four spacer sections which are inserted between the Bus Bars and the DUCT and a top cover section all held in place by a steel cover fastened on four studs.

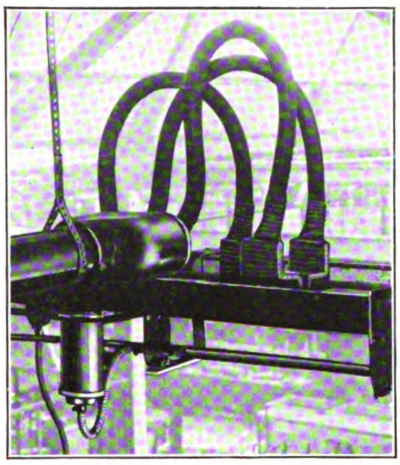
Fusible Switch Plugs showing the Blades at one end which fit into the contact fingers of the Receptacle illustrated immediately above. Cartridge Fuses are accessible through the window in the bakelite housing which may be revolved opposite any fuse. An aluminum casting at either end completes and protects the Plug.



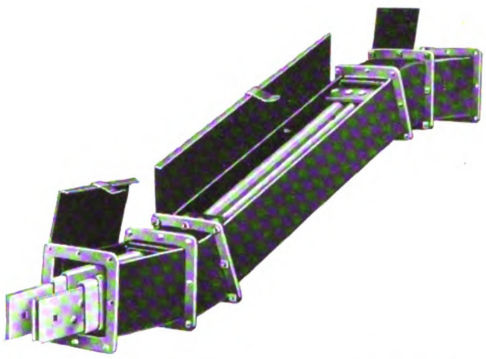
Section of an installation showing Bus-DUCT with Fusible Plug attached, and one of the Fuses visible through an opening caused by revolving the housing of the Plug which ordinarily is provided with an interlocking feature which prevents access to the Fuses without first disconnecting the Plug from the Bus Bars.

Bus-DUCT

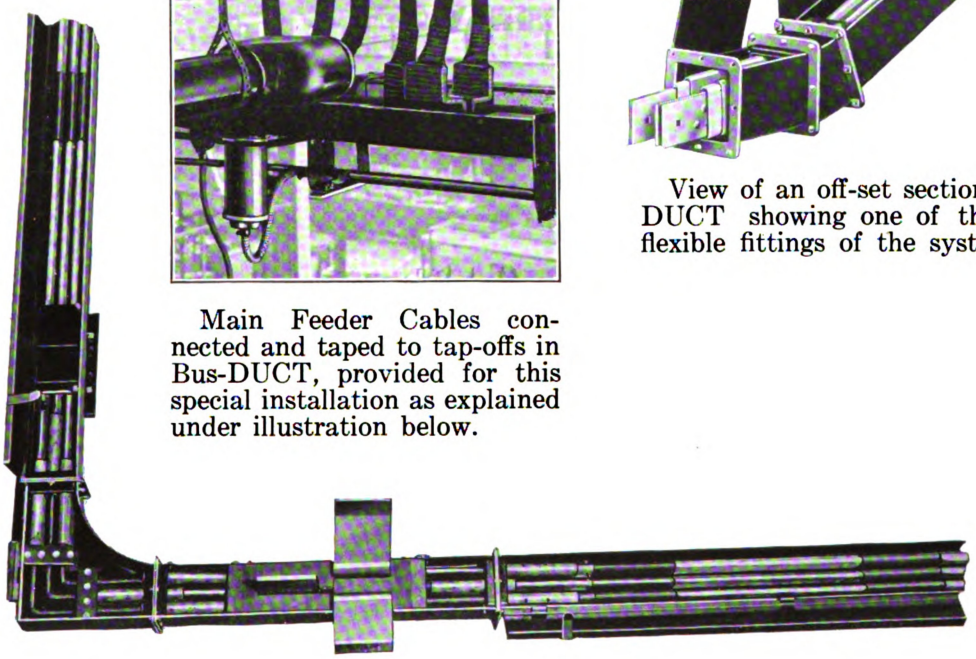
Top view of a section of Bus-DUCT with Hinged Cover raised giving ready accessibility at all times to the insulated Bus Bars. This also shows a Cable Terminal Junction Box with the cover removed. The piece in center is the top cover plate of a Plug Receptacle on either side of which, on 20″ centers, may be seen fibre insulation sleeves held in place by wooden pins which may be readily sheared off and the sleeves slipped back to expose the Bus Bars for the attachment thereto of additional Receptacles, if needed.



Main Feeder Cables connected and taped to tap-offs in Bus-DUCT, provided for this special installation as explained under illustration below.

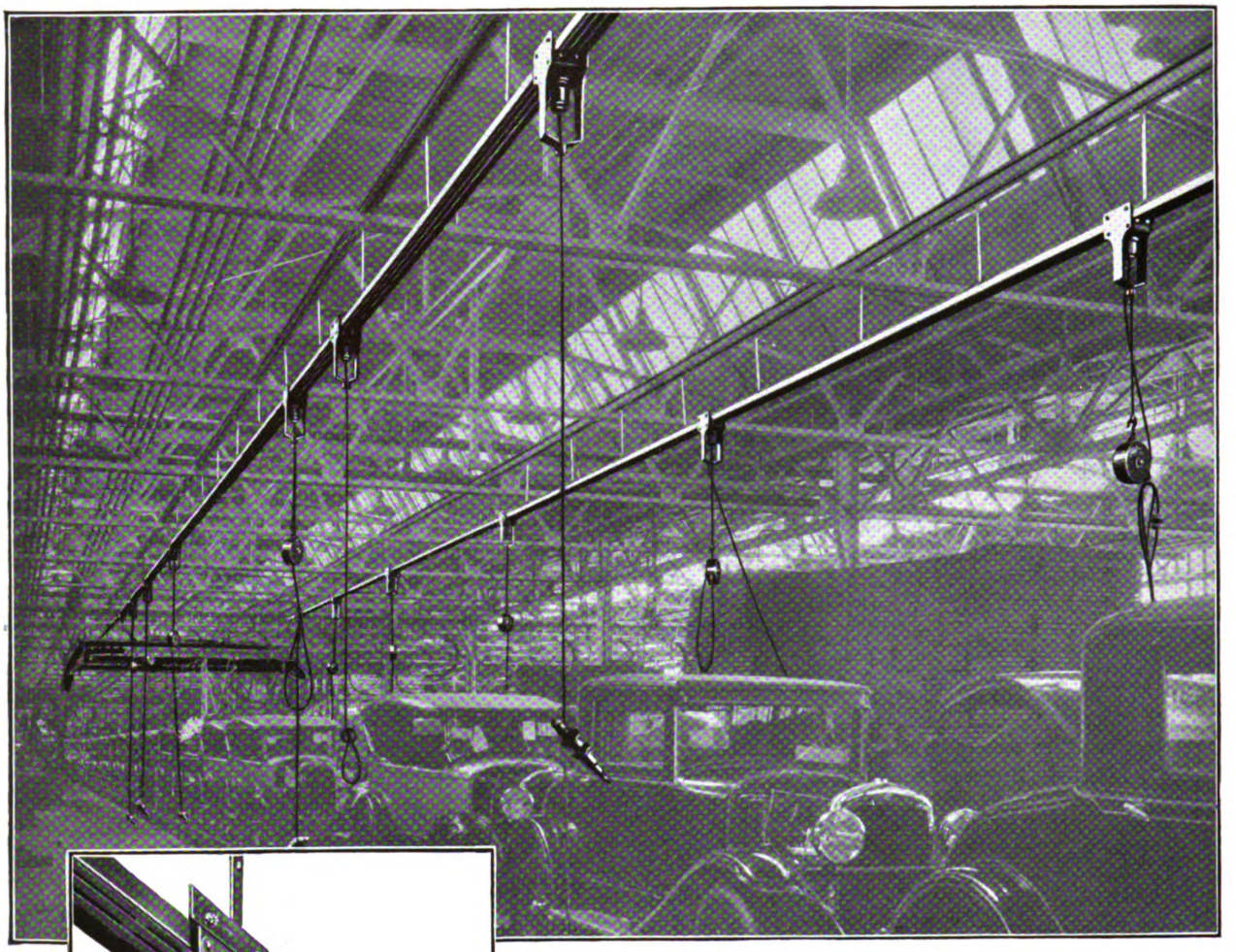


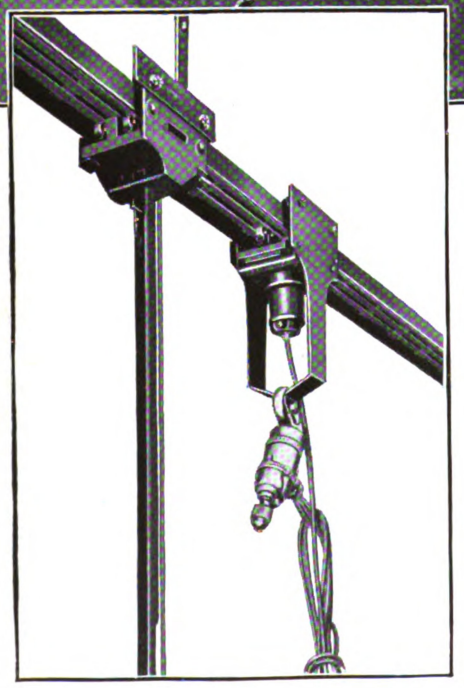
View of an off-set section of Bus-DUCT showing one of the many flexible fittings of the system.



Section of Bus-DUCT with the Hinged Covers raised and a right angle turn. This also illustrates an external method of feeding the Bus-DUCT by means of tap-offs, as specified for this particular installation. See cut immediately above showing connections as finally installed.

Trolley-DUCT





Trolley-DUCT used on the Assembly Line of a large Automobile Plant enabled them to increase their Production 20%.

Note the Pedwyn Balancer by which fairly heavy tools can be raised or lowered to suit the convenience of the mechanic.

Insert shows close up of the Trolley Channel with Bus Bars and two types of Trolley Carriages—the Portable Type and the semi-permanent or Balancer Type.

Trolley-DUCT

Purpose of System

BULL DOG Trolley-DUCT is a flexible system of Electrical Control for Portable Tools as used on moving assembly lines in Automobile and other Mass Production Plants.

Design and Construction

Trolley-DUCT consists essentially of standard lengths of 5″ steel channel, mounted inverted—the top part of which constitutes the track for the Trolley Carriage. On the bottom side or channel proper, Bus Bars suitably insulated, are installed.

The current is taken from the Bus Bars by means of Collector Wheels in the Trolley Carriage and conveyed through Fuses to the cord connecting the individual Portable Tools.

Bus Bars

The inside of the steel channel is first lined with a heavy formed fibre piece and then 3 Bus Bars, one for each phase, are mounted on the inside of the channel on insulated supports. The Bus Bars are so arranged that the one nearest the channel flange is mounted about ¼″ higher than the others, and in this manner the Carriages cannot be reversed. Furthermore this assures that the tools operated by the Carriages will always run in one direction.

The Bus Bars are provided with slip joints whereby the channel sections can be slipped into one another and then tightened by means of screws, so as to form a continuous Bus Bar for each phase, throughout the length of the DUCT.

Suitable taps are then provided to feed the Bus Bar, which has a capacity of approximately 150 Amperes.

Trolley Carriages—two types

(1) The heavy duty Balancer Type Carriage, semi-permanent, as compared with (2) the Portable Type which can be instantly detached from one section of the Trolley-DUCT and snapped on to another section.

The heavy duty Balancer Type Carriage is termed semi-permanent as it can be taken off the Trolley-DUCT and put in another location by simply removing a few bolts. These Carriages roll along the top of the inverted steel channel on wheels with hardened ball bearings and hardened outer sleeves. The Collector Wheels run on the Bus Bars in the channel beneath. They are also ball bearing with copper rims and have a continuous capacity of 30 Amp. There are two Collector Wheels, spaced several inches apart, on each Bus Bar so that it is impossible for the tools to operate single phase. These heavy duty Balancer Type Carriages are used by a great many Industrial Plants to carry Pedwyn Balancers which support fairly heavy tools which can be raised up and down by means of these Balancers and backwards and forwards by the Trolley Carriage. A Plug Receptacle is incorporated in these Carriages for which we furnish a Fusible Plug having Fuse Connections for 30 Amp. 250 Volt and 30 Amp. 600 Volt Cartridge Fuses.

The Portable Type Carriage is lighter in construction but similar to the Balancer Type in its mechanical and electrical operation except that it can be instantly attached to or detached from the Trolley-DUCT.

In the Portable Type, the Fuse Block for 250 Volts is mounted in the Carriage proper, while for 600 Volts it is mounted on the handle directly under the Carriage. (See page 11)

The Portable Carriage is so designed that in putting it on the track it cannot be short-circuited and it is self-guiding so that it can be put on with one hand. When once it is snapped on, it is locked in position by means of a trigger catch on the handle shaft which is again released when snapping the Carriage off the track. All this is done with one hand, leaving the other free to carry tools or for other purposes.

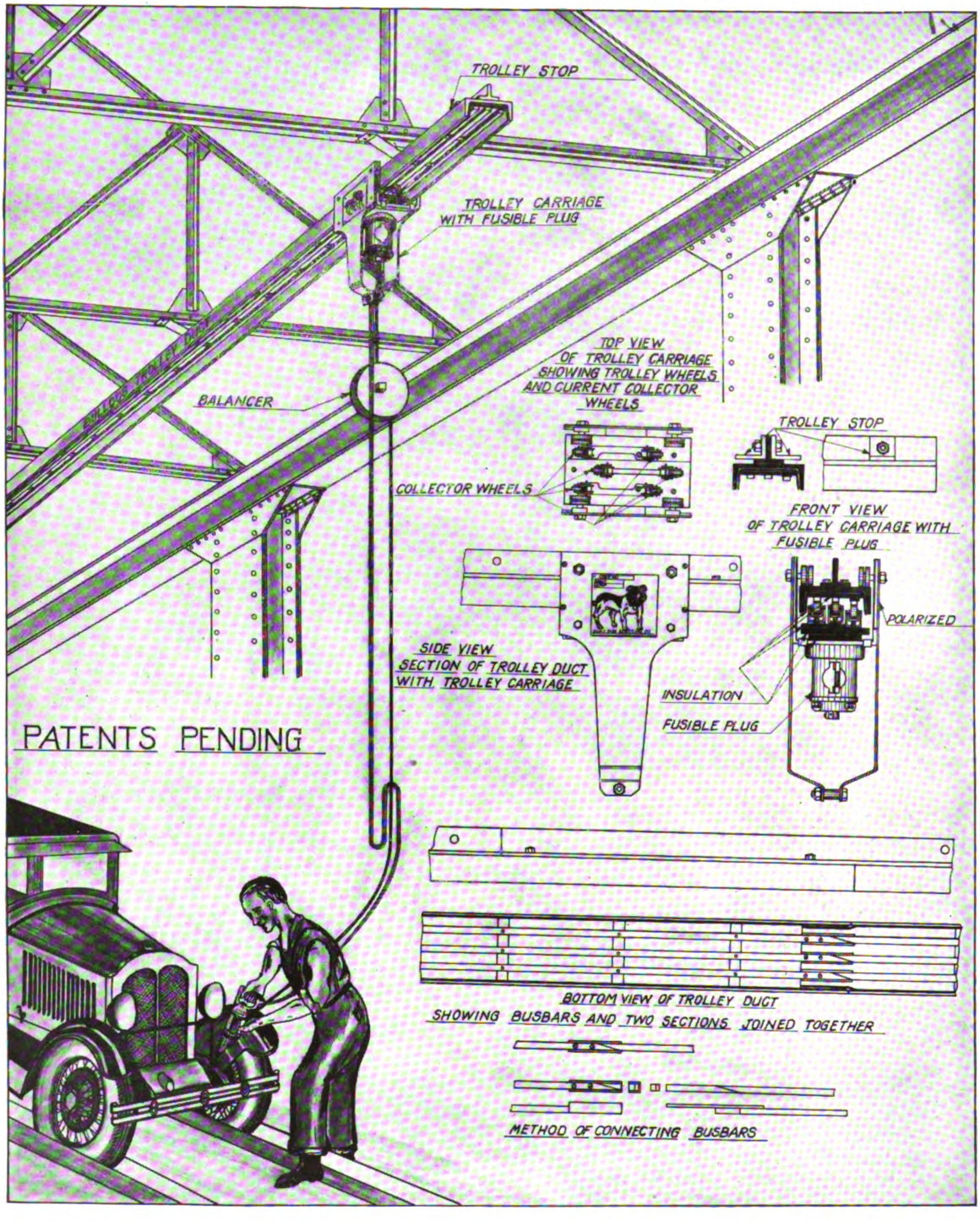
Both these Carriages have ball bearing rollers for support as well as ball thrust side bearing which keep them from being locked in any position on the channel and the Carriages move with such ease that the Operator is hardly conscious of pulling the Carriage along when moving the tool.

System Grounded and Polarized

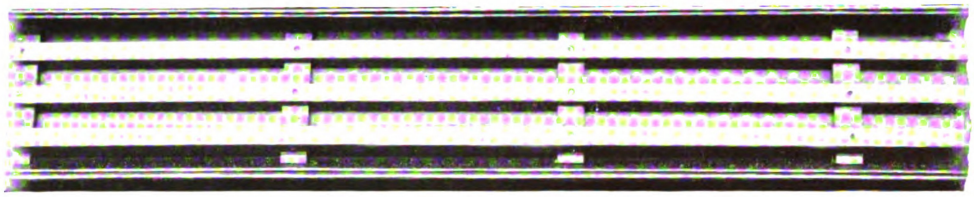
The Trolley Wheels which travel along the top of the DUCT carry the ground from the DUCT to the Portable Tool thus giving effective grounding throughout. The DUCT also serves in conjunction with the Trolley Carriages to completely polarize the system.

Trolley-DUCT

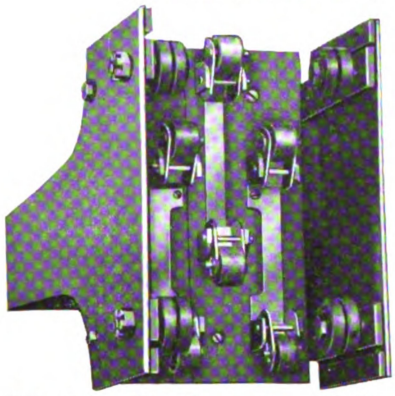
CONSTRUCTION DETAILS AND APPLICATION OF THE *BALANCER TYPE* CARRIAGE



Trolley-DUCT

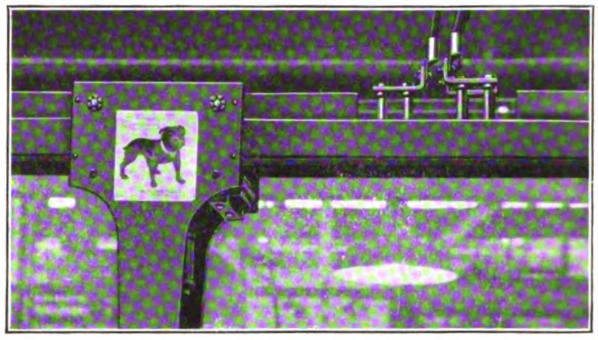


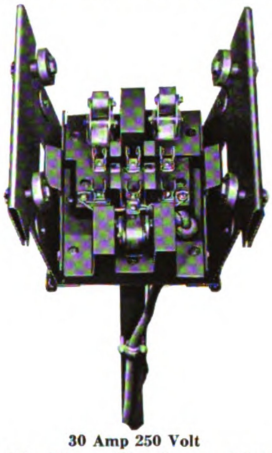
Underneath view of Trolley-DUCT showing the inverted steel channel lined with a heavy formed fibre and the three Bus Bars, one for each phase, mounted on insulated supports.



Illustrating the three sets of ball bearing Collector Wheels (two for each Bus) which travel along the Bus Bars. They are provided with springs to effect contact and have a continuous capacity of 30 Amp. The four wheels on the side sections are the Trolley Wheels, which are also ball bearing and travel along the top of the inverted steel channel.

Section of a Trolley-DUCT installation showing a Balancer Type Carriage in position and a tap-off section with Feeder Cables connected to Terminal Lugs, prior to Feeder section being enclosed.





30 Amp 250 Volt

Portable Type Carriage which can be instantly removed and attached to any other part of the Trolley-DUCT. Similar in operation to the Balancer or more permanent Type Carriage but lighter in construction because of its portable nature. The Fuse Block is mounted between the Collector Wheels in lieu of the Fusible Plugs as used in the Balancer Type Carriages.

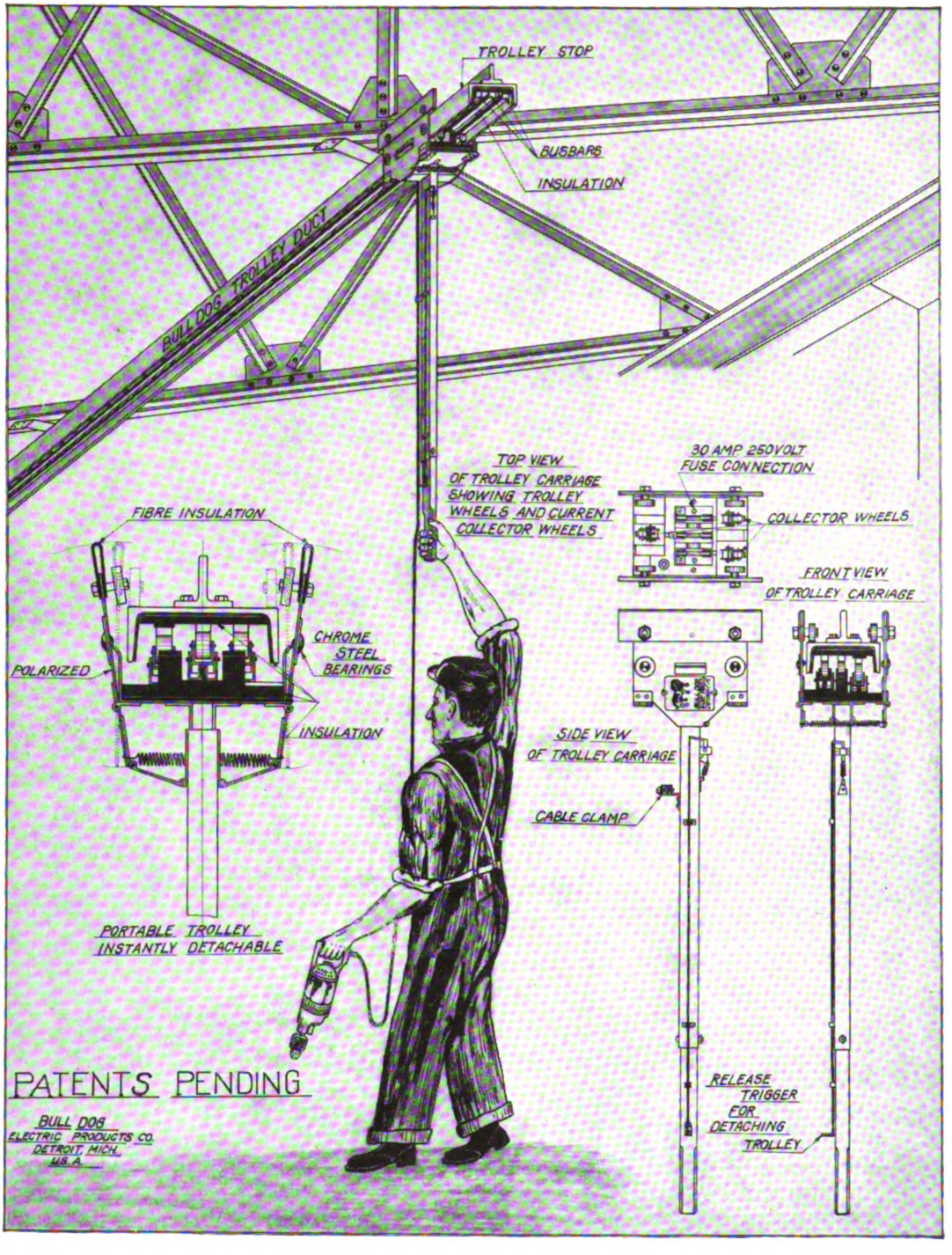
View of Balancer Type Carriage with Fusible Plug attached. The Carriage moves backwards and forwards with the operator, by means of the wheels on the side sections which travel along the top of the Trolley-DUCT while the wheels (termed Collector Wheels) in the middle section of the Carriage, move along the Bus Bars in the channel beneath and feed the current through the Fusible Switch Plug and the cable connected to the Portable Tool below.

30 Amp 600 Volt

Portable Type Carriage showing the Fuse Block mounted on the handle shaft, instead of in the carriage proper. In practice a shield covers the live fuse block. This type used by the world's largest Manufacturers of Automobile Bodies.

Trolley-DUCT

CONSTRUCTION DETAILS AND APPLICATION OF THE *PORTABLE* TYPE CARRIAGE

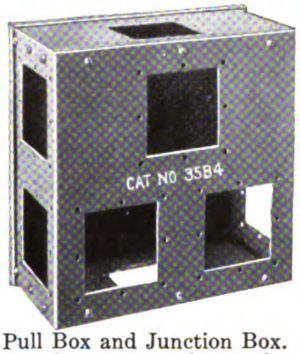


Bull Dog pro-DUCT—The Original Wiring DUCT Fully Described and Listed in Catalog 29

The cuts shown below are some of our pro-DUCT Line (Wiring Troughs and Fittings) and are reproduced here as all of these Fittings can be accommodated to our Bus-DUCT.
It will be readily appreciated therefore that with these Ells, Tees, Junction Boxes and other Fittings, Bus-DUCT installations of extreme flexibility can be provided for.

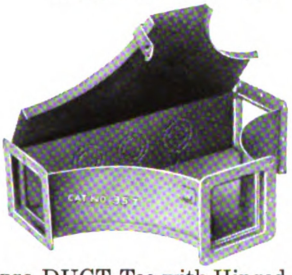
Bull Dog DUCT is furnished in standard lengths of 5 ft., 2 ft. and 1 ft., provided with numerous knockouts. The Hinged Cover gives instant access to all wires or Bus Bars at any section of the system which greatly facilitates inspection and maintenance.

Bull Dog pro-DUCT Nipples are short lengths of DUCT which may be inserted between standard lengths to secure any necessary variations.



Pull Box and Junction Box. **Openings not used may be closed with End Plates.**

90°, 45° and 22½° pro-DUCT Elbows.

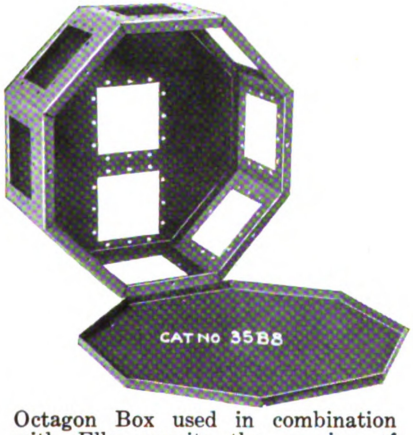


pro-DUCT Tee with Hinged Cover and Knockouts conveniently located.

Conduit Couplings

End Plates or Closing Plates

pro-DUCT Slide Nipple—minimum length 8″ can be extended to 13″—provided with flanges to fit standard lengths of DUCT.



Octagon Box used in combination with Ells permits the running of DUCT in any direction.

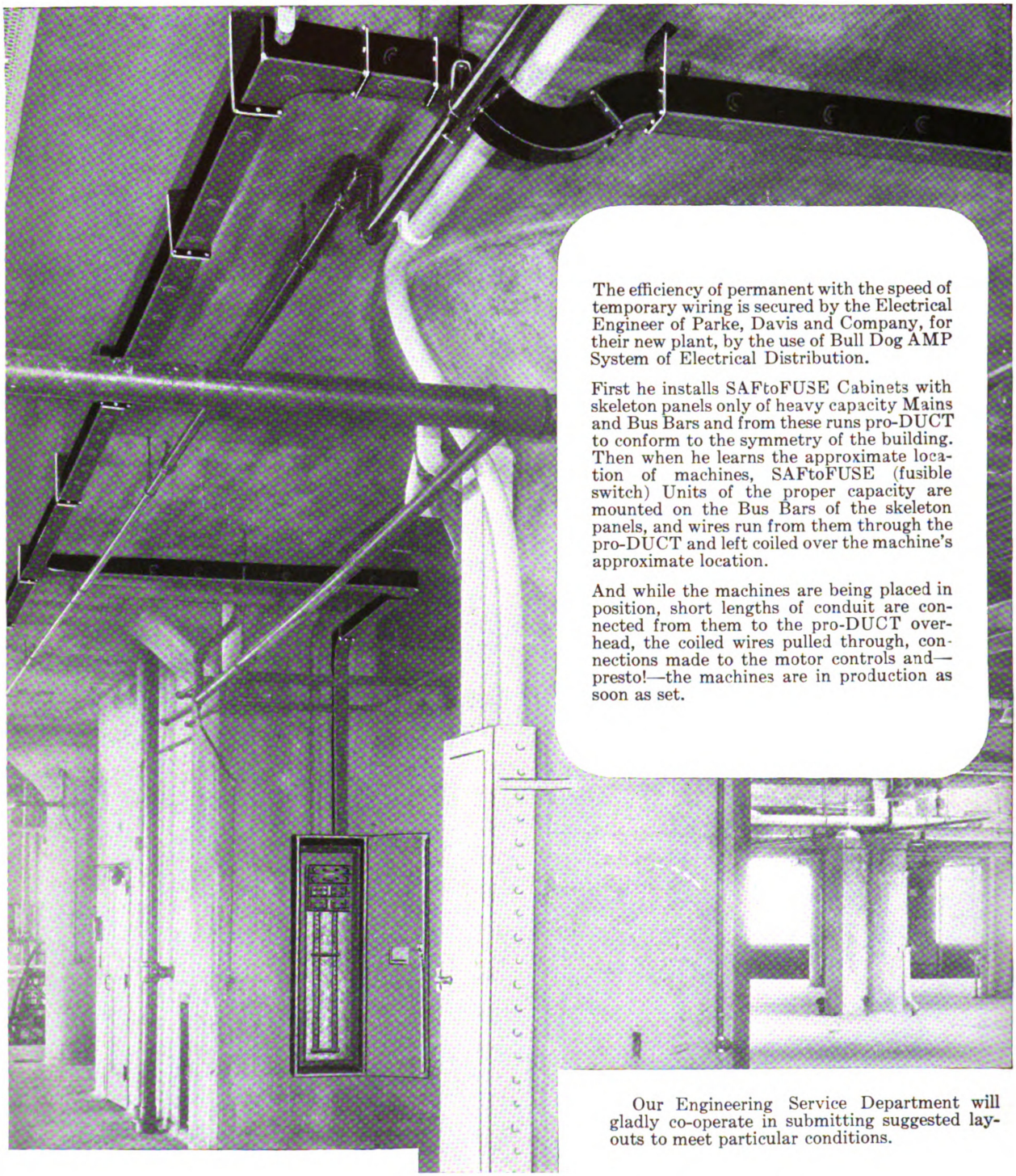
90° Corner Elbow is a combination Elbow and Pull Box with suitable knockouts. Also has hinged cover.

pro-DUCT Cross, provided with double hinged covers, may be used as a Pull Box.

Pro-DUCT with SAFtoFUSE Panelboards

Electrical Distributing System consisting of Bull Dog pro-DUCT (Wiring Troughs and Fittings) in conjunction with Bull Dog SAFtoFUSE Light and Power Panelboards and Cabinets.

Installed in the new Plant of Parke, Davis and Company, Detroit, World's Largest Manufacturers of Pharmaceutical Products.



The efficiency of permanent with the speed of temporary wiring is secured by the Electrical Engineer of Parke, Davis and Company, for their new plant, by the use of Bull Dog AMP System of Electrical Distribution.

First he installs SAFtoFUSE Cabinets with skeleton panels only of heavy capacity Mains and Bus Bars and from these runs pro-DUCT to conform to the symmetry of the building. Then when he learns the approximate location of machines, SAFtoFUSE (fusible switch) Units of the proper capacity are mounted on the Bus Bars of the skeleton panels, and wires run from them through the pro-DUCT and left coiled over the machine's approximate location.

And while the machines are being placed in position, short lengths of conduit are connected from them to the pro-DUCT overhead, the coiled wires pulled through, connections made to the motor controls and—presto!—the machines are in production as soon as set.

Our Engineering Service Department will gladly co-operate in submitting suggested layouts to meet particular conditions.

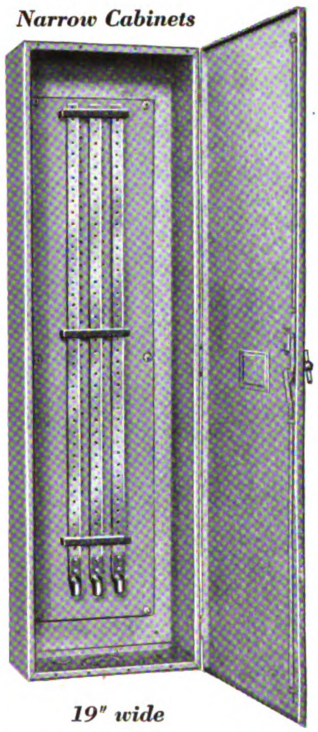
BULL DOG SAFtoFUSE DISTRIBUTION PANELS

Reduce Initial Investment—Provide for Future Circuits

Built up of individual Fusible Switch Units, Bull Dog SAFtoFUSE Panels enable the Engineer to handle any Loads, Combinations of Loads and Changes of Loads in the most economical manner.

AT First Install Only The Panel-board Shell

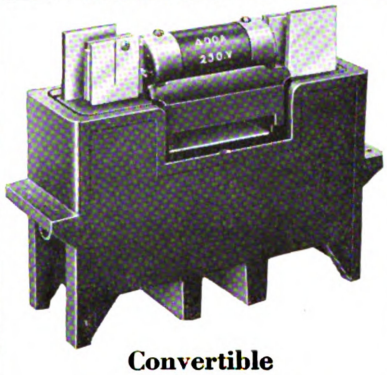
Narrow Cabinets



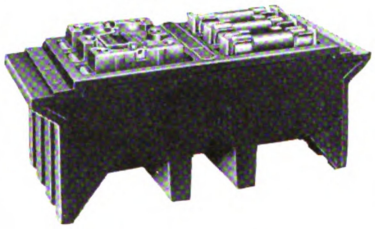
19" wide

A Large Enough Box With Ample Bus-Bars

BUY Only The Units Needed At Present



Convertible



Interchangeable

Safe To Fuse

Future Circuit Provisions

CABINET Now Exactly Fits Your Present Requirements

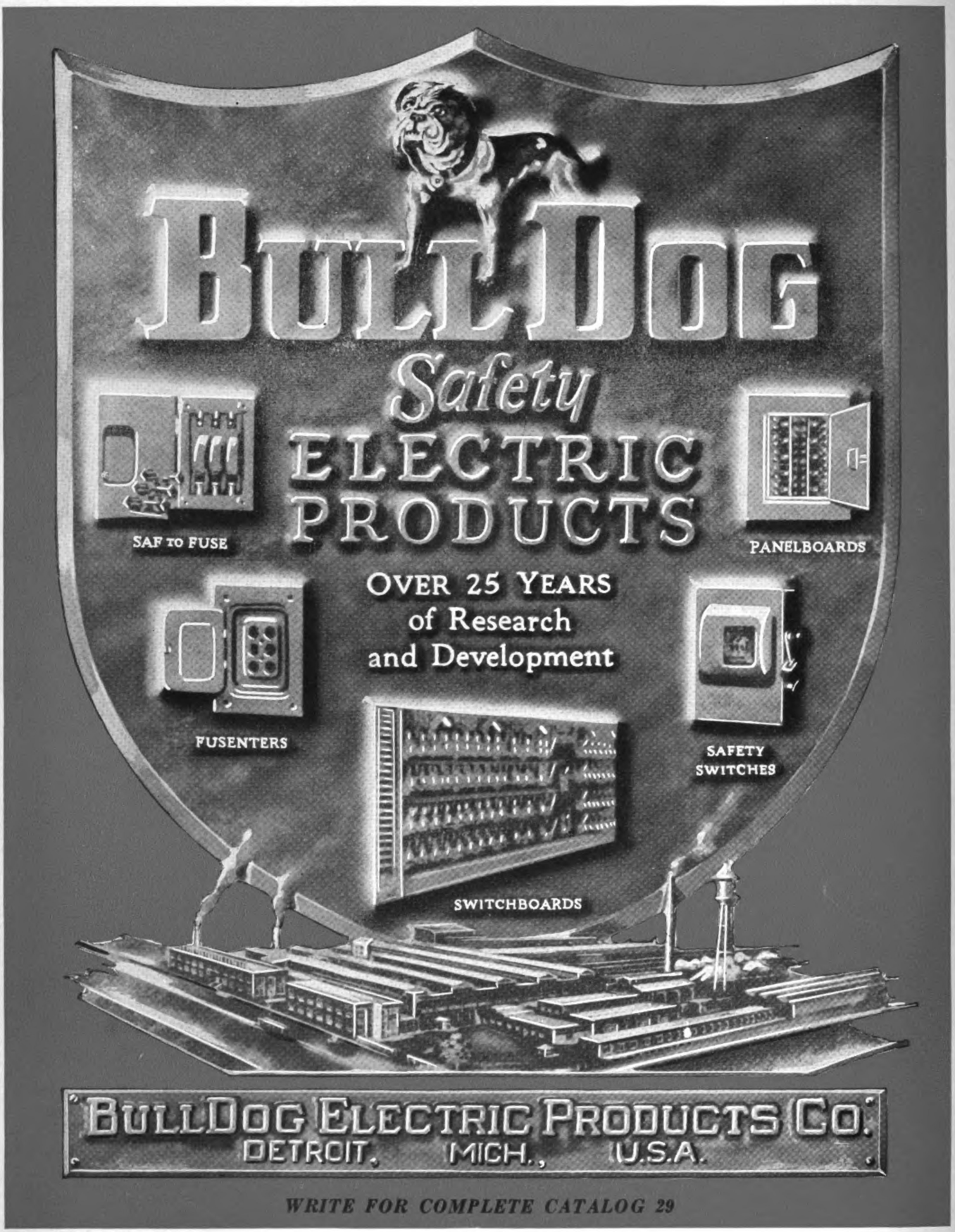
250—600 Volts

30—600 Amperes

—And It Can Be Changed To Meet Any Future Need

Write for complete Catalog 29 fully illustrating and describing

Bull Dog SAFtoFUSE System of Electrical Distribution



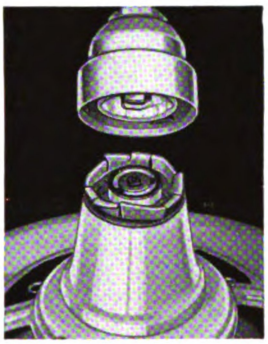
WRITE FOR COMPLETE CATALOG 29

R. S. CO. 10-29

PRINTED IN U. S. A.

The New Benjamin Type '79
GLASSTEEL DIFFUSER

With Reflector, Lamp and Globe Detachable as a Complete Unit for Easy Cleaning



Best engineering practice recognizes the following six fundamentals as essential to every system of adequate industrial lighting:

I. There must be adequate light for the work.

II. There must be freedom from direct and reflected glare.

III. There must be freedom from harsh shadows and sharp contrasts.

IV. There must be a fair degree of light on the side walls and ceiling.

V. The light must be of a color best suited for the work.

VI. Lighting equipment must be simple, reliable and easy to maintain.

For practically any workroom, factory or factory office, these six lighting fundamentals are squarely met by the new Benjamin Type '79 Glassteel Diffuser.

I. When installed to recommendations of the Benjamin Handbook, "A Guide to Productive Lighting," the new Type '79 Glassteel Diffuser provides soft, even light over a wide range of intensities.

II. Direct and reflected glare is eliminated by the combined action of the porcelain enameled reflector and diffusing glass globe.

III. Mounted at recommended spacings, Benjamin Type '79 Glassteel Diffusers eliminate harsh shadows and soften contrasts by providing uniform illumination of well diffused light.

IV. Openings at the top of the reflectors give ample light on the ceiling to relieve contrasts between the fixture and its background, and the entire room is made more cheerful.

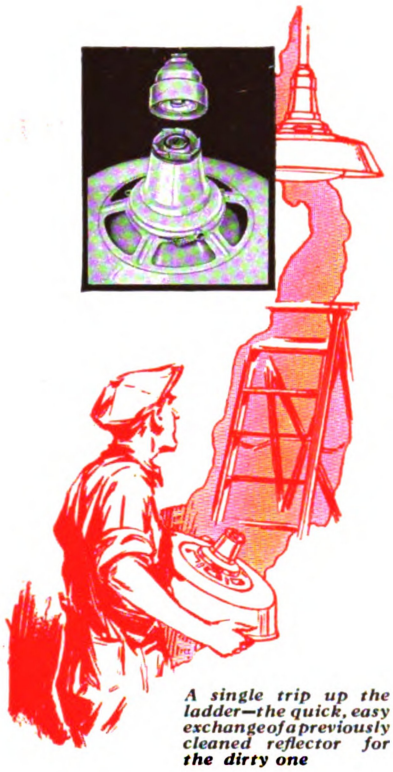
V. Daylight globes may be had for use where color discrimination is needed.

VI. Extremely rugged and simple, the new Benjamin Type '79 Glassteel Diffuser embodies an entirely new principle of construction that will maintain the original efficiency of the lighting system at the lowest possible cost for cleaning.

Certified by BENJAMIN

This is only one of many lighting units Certified by Benjamin

Easily Put Up and Easily Taken Down



A single trip up the ladder—the quick, easy exchange of a previously cleaned reflector for the dirty one

The new Benjamin Type '79 Glassteel Diffuser is composed of two separable elements—a hood with a wiring terminal base and a complete assembly of reflector, globe and lamp, which can be taken down as one piece for easy cleaning.

A slight upward pressure against the reflector rim, less than a quarter turn to the left and the reflector assembly is released from the hood. It is just as *simple* to put up—simply turn right and reflector is secured.

Carrying out a scheduled cleaning program in the plant is thus materially simplified and attended by considerable savings in labor time.

With a few extra reflector units on hand, it is possible for a maintenance crew to change an entire bay at a time. They simply *take down* the dirty reflectors and substitute in their place fixtures which have been cleaned previously on the floor or at the bench.

No time is wasted — no pails and cleaning rags need be taken up the ladder—the entire operation, with the new Benjamin Type '79 Glassteel Diffusers, is simple, safe, convenient and unusually economical.

Simple - To - Wire Terminal Base

The terminal base in the hoods of Benjamin Type '79 Glassteel Diffusers is extremely *simple to wire.*

Both wiring leads are brought in through the single center hole in the hood and terminal base. There is no chance of twisting or breaking the wires. From the center lead-in hole to either terminal screw is but a short space.

The entire wiring space is generously large and conveniently shallow. There is *ample room* to use a man-sized screw driver. No porcelain bases or terminal caps need be removed to gain access to the terminal screws—and there are no parts to be fastened in place after the wiring operation has been completed.

Large, flat-headed terminal screws with heavy shanks, allow *quick attaching* of wires without removal of the screws or previous looping of the leads. Wire sizes up to and including No. 10 stranded can be attached conveniently.

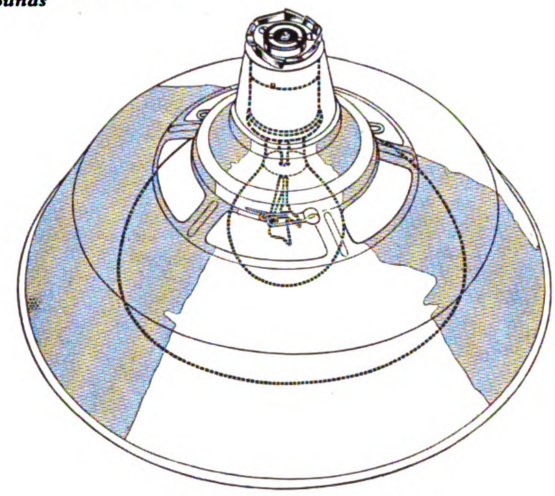
Single center lead-in hole and large accessible terminal screws make wiring easy

It is but a *minute's work* to wire the terminal base of a Benjamin Type '79 Glassteel Diffuser. Insert the wiring leads through the large center hole, back off the terminal screws a bit and loop the skinned wire tips under the broad, flat heads of the screws, turn down the screws—and the job is complete.

Simple, convenient wiring is but an indication of the *modern, accessible design* that characterizes every detail of the new Benjamin Type '79 Glassteel Diffuser.

Simple, Rugged and Durable

In tests this rugged, positive bayonet lock mechanism has supported safely dead weights in excess of 200 pounds



The hood and reflector assembly of Benjamin Type '79 Glassteel Diffusers are effectively locked together by a three-point bayonet coupling.

Electrical and mechanical connection between the hood and reflector, is made simultaneously with the engagement of the bayonet lock. The terminal base in the hood is backed by a spiral compression spring which maintains the contacts of the hood and reflector in positive electrical engagement.

Terminal base and lamp holder contacts are circular in form with broad, flat surfaces which are self-cleaned by the turn of the reflector as it is engaged in the hood. Contact is made at any point where the reflector heel may be entered in the hood—as there are no tongues or contact prongs to locate. *Polarization is always automatically* provided for by the circular design of the contacts.

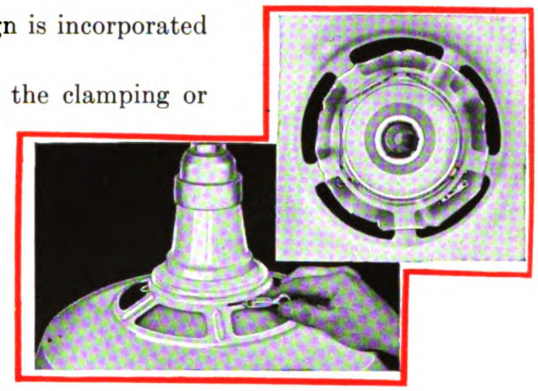
The lamp holding element is built into the reflector so that the lamp is always maintained in correct position in relation to the reflector.

Quicker Globe Removal

A safe, quick-acting globe holder of advanced design is incorporated in the new Benjamin Type '79 Glassteel Diffuser.

A single lever on the side of the reflector controls the clamping or release of the globe in the fixture. Relamping time is thus *materially lessened.* A cadmium plated wire band, that makes contact over 75 per cent of its circumference, encircles the neck of the globe, holding it securely.

There are no annoying screws to loosen—no tools required—and there is ample provision for globe expansion under heat.



Specifications

Reflector—Porcelain enameled steel, in three sizes, with Benjamin Type '79 bayonet-lock coupling. Reflectors have built-in lamp holders and bayonet plate. Standard reflector has aperatures at the top for the passage of light to the ceiling.

Terminal Base—National Electrical Code Standard, simple-to-wire. One type of terminal base is standard in both outlet box and pendent type hoods and accommodates reflectors with Medium or Mogul base lamp holders.

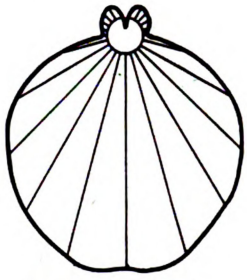
Hoods—Two types of hoods are provided, outlet box and pendent. Outlet type hood has one hole slotted for easy attachment.

Tapping—Standard pendent hoods are tapped for ½ inch conduit; can be supplied in ¾ inch, when specified.

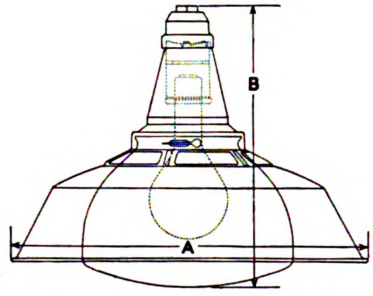
Finish—Reflectors are white porcelain enameled inside and out, with blue-black bead. Spring Clamp Globe Holder, Hood and Bayonet Plate are cadmium plated to prevent corrosion.

May 1, 1929

New Benjamin Type '79 Glassteel Diffuser



Typical distribution curve.



Complete With Hood, Reflector and Globe

With Pendent Hood

Pendent Hoods are cast iron tapped ½ inch, standard; ¾ inch, if specified.

Size of Lamp, Watts	With Opal Glass Globe: Catalog No.	List Price	Cat. No. Globe	With Daylight Glass Globe: Catalog No.	List Price	Cat. No. Globe	Dim. in Inches: Diam. "A"	Height "B"	Ship., Wt. Std. Pkg.
*150, 200	7201	$ 9.25	26347	7226	$ 9.75	26346	18	13	34
300, 500	7202	12.75	26349	7227	13.50	26348	20	15 5/16	40
750, 1000	7203	18.75	26351				24	18 1/16	40

Standard Package is 4 on 18 and 20″ units and 2 on 24″.

With Ceiling Type Hood

Ceiling type hoods are of cast iron and fit 4 inch standard Outlet Boxes.

Size of Lamp, Watts	With Opal Glass Globe: Catalog No.	List Price	Cat. No. Globe	With Daylight Glass Globe: Catalog No.	List Price	Cat. No. Globe	Dim. in Inches: Diam. "A"	Height "B"	Ship., Wt. Std. Pkg.
*150, 200	9201	$ 9.25	26347	9226	$ 9.75	26346	18	12½	35
300, 500	9202	12.75	26349	9227	13.50	26348	20	14 13/16	41

Standard Package is 4 on 18 and 20″ units and 2 on 24″.

Extra Reflectors For Easy Maintenance of System

Consisting of Reflector, Lamp Holder and Globe

Size of Lamp, Watts	With Opal Glass Globe: Catalog No.	List Price	Cat. No. Globe	With Daylight Glass Globe: Catalog No.	List Price	Cat. No. Globe	Dim. in Inches: Diam.	Height	Ship., Wt. Std. Pkg.
*150, 200	201	$ 8.45	26347	226	$ 8.95	26346	18	11 1/16	28
300, 500	202	11.95	26349	227	12.70	26348	20	13 3/8	34
750, 1000	203	17.95	26351				24	16 1/8	37

Standard Package is 4 on 18 and 20″ units and 2 on 24″. Prices Do Not Include Wires or Lamps.

With Shock Absorbing Lamp Holders

Shock absorbing lamp holders, an exclusive feature of Benjamin Equipment, lengthen lamp life by protecting the lamp filament against the jars and shocks present in every industry. Shock absorbing lamp holders are furnished in place of the regular rigid lamp holder at an advance of 10 cents in list price. Specify "with shock absorbing lamp holders" when ordering.

Globes Only for Replacement

Size of Lamp, Watts	Opal Glass: Catalog No.	List Price	Daylight Glass: Catalog No.	List Price	Dimen. in Inches: Diam.	Height	Std. Pkg.
.... 200	26347	$2.30	26346	$2.80	10	5	4
300, 500	26349	3.60	26348	4.35	12	6	4
750, 1000	26351	7.25			16	9 7/8	2

*When using 150 watt lamp, Socket Extension No. 91 must be used to correctly position lamp in reflector.

	SYMBOLS
	CEILING OUTLET
	BRACKET "
	PLUG "
	LIGHTING PANEL
	POWER "
	PULL BOX
	TELEPHONE

MICHIGAN STATE COLLEGE
DEPT. OE ELEC. ENGINEERING

LIGHTING LAYOUT FOR A FACTORY BUILDING

DRAWN	L. A STROBEL	SCALE	1/16" = 1'-0"
TRACED	"	DATE	MAY 1 1930
CHECKED		SHEET	E - 1

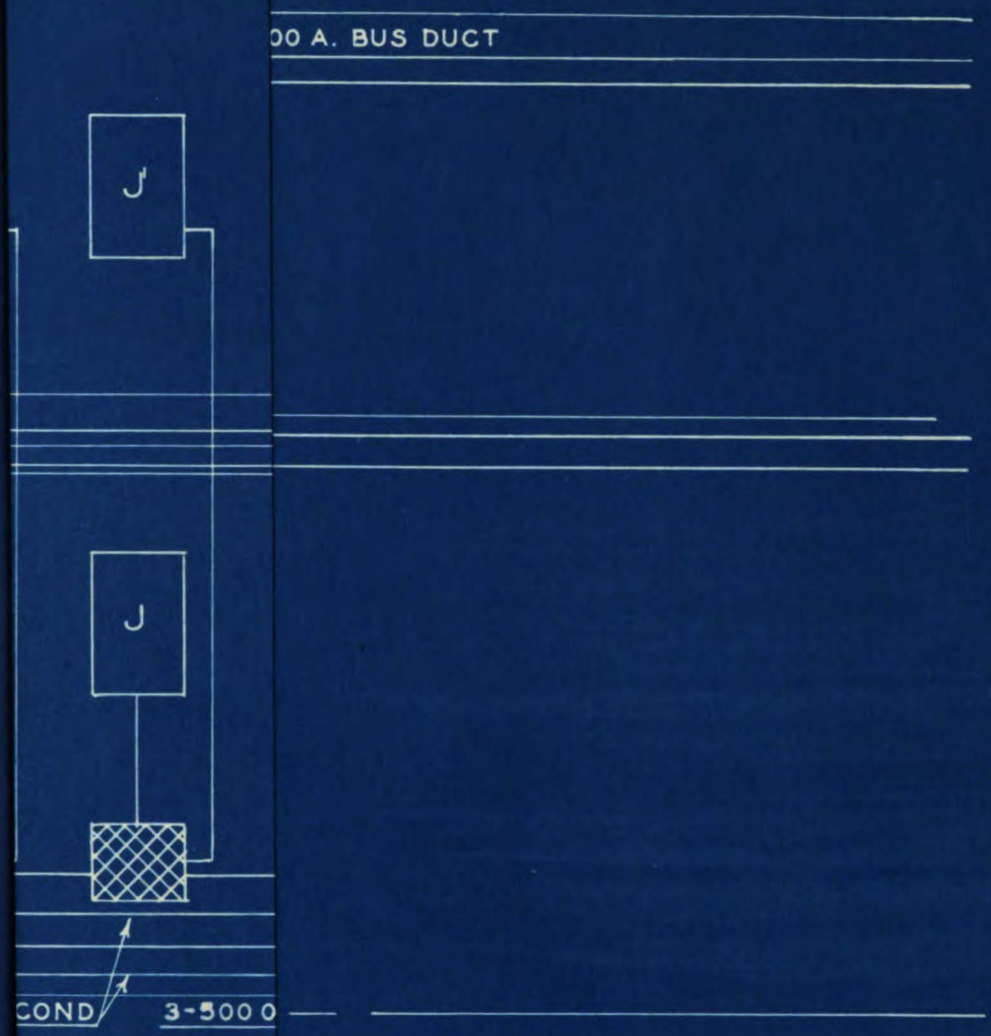
May 1,
1929

AD23

MICHIGAN STATE COLLEGE
DEPT. OF ELEC. ENGINEERING

POWER LAYOUT FOR A FACTORY BUILDING

DRAWN	L. A. STROBEL	SCALE	1/16" = 1'-0"
TRACED	"	DATE	MAY 25 1930
CHECKED		SHEET	E - 2



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RISER DIAGRAM
FACTORY BUILDING

DRAWN	L. A. STROBEL	SCALE	NO SCALE
TRACED	"	DATE	MAY 28 1930
CHECKED		SHEET	E-3