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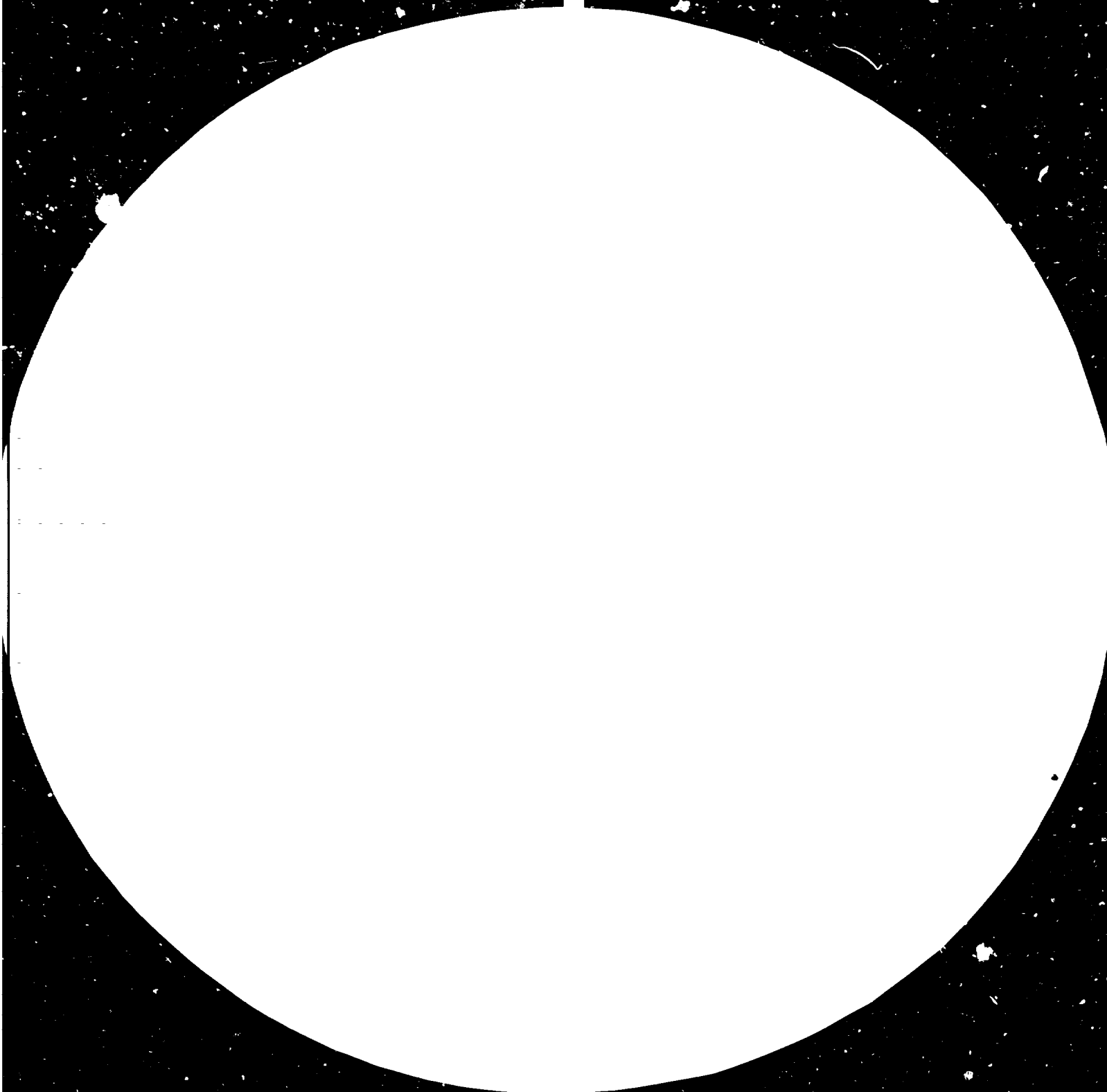
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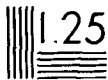


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MINING METHODS AND ADVANTAGES BY USING
HYDRAULIC EXCAVATORS *

by

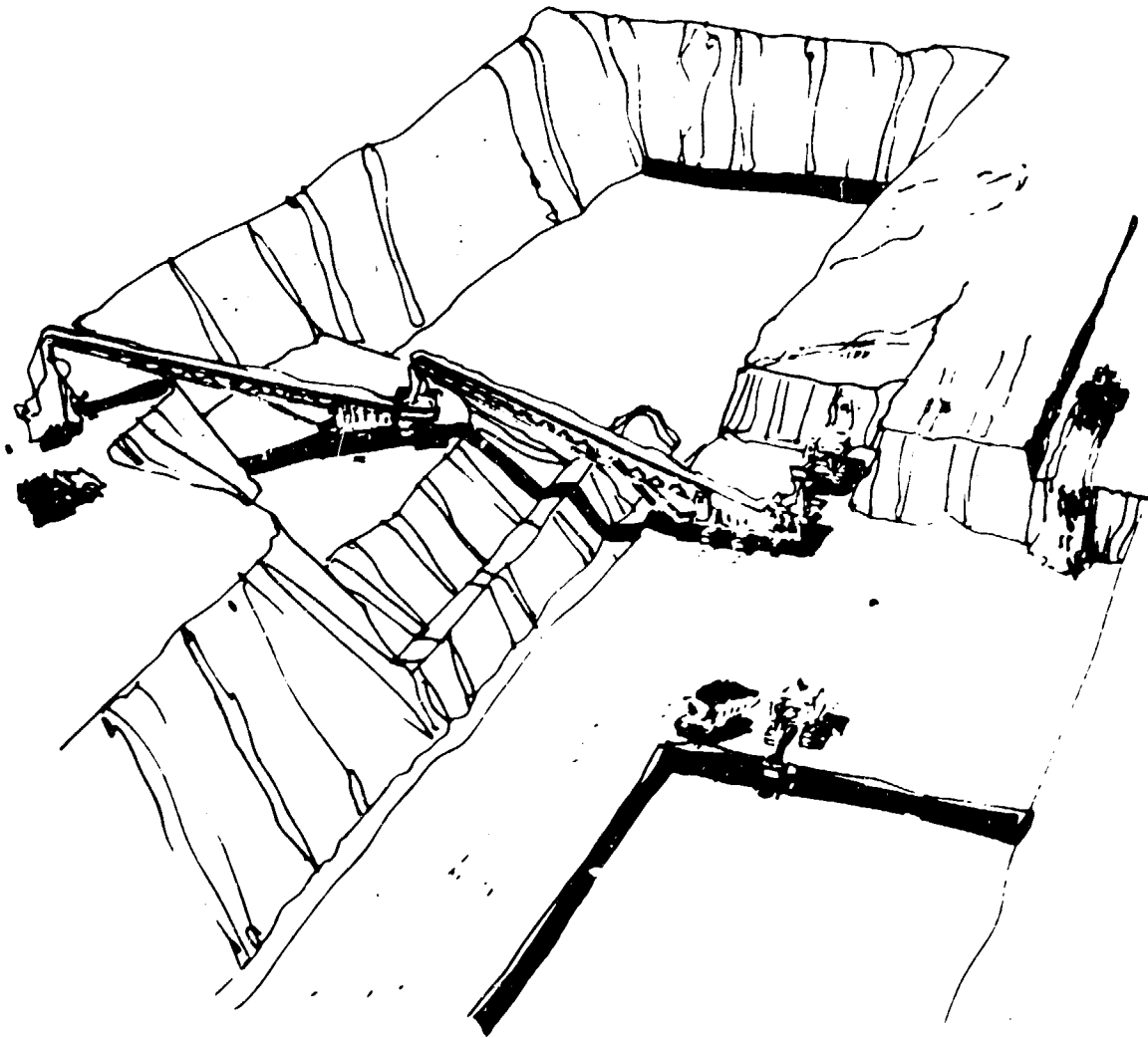
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MINING METHODS AND ADVANTAGES BY USING

HYDRAULIC EXCAVATORS



OPEN-CAST-MINING

IN "OPEN-CAST-MINING", THERE ARE - AT LEAST - TWO "LOADING SITUATIONS" WHICH WARRANT BASICALLY DIFFERENT METHODS.



THE "CONTINUOUS METHOD" WHICH IS USING BUCKET-WHEEL EXCAVATORS (OR SIMILAR ROTARY LOADING TOOLS) TO DIG AND LOAD, AND CONVEYOR BELTS TO TRANSPORT THE MATERIAL MINED. CAPACITIES VARY FROM 2,000 T.P.H. TO 50,000 T.P.H. CONVEYOR BELTS WIDTHS GO UP TO 4.0 M AND CONVEYOR

1 SPEEDS UP TO 4.5 M.P.SEC.



THIS SYSTEM IS DEVELOPED TO ULTIMATE PERFECTION IN RHEIN-BRAUN IN WEST GERMANY, WHERE A YEARLY AVERAGE OF 120 MILLION TONS OF LIGNITE AND 300 MILLION TONS OF OVERBURDEN ARE MOVED

2 BY THIS METHOD.

OPEN-CAST-MINING

PREREQUISITES TO ITS USE ARE:

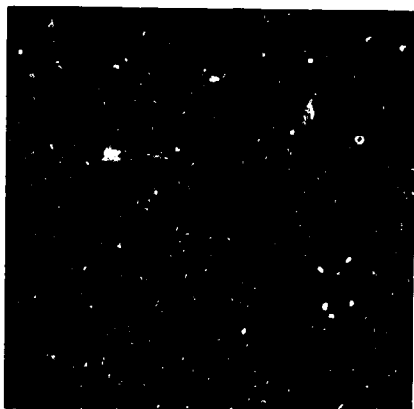
A PREFERABLY ALLUVIAL DEPOSIT WITH
SOFT, HOMOGENEOUS MATERIAL.

THE DEPOSIT HAS TO BE OF BIG VOLUME
AND GEOLOGICALLY UNDISTURBED SO
THAT THE MACHINES WHICH ARE COMPA-
RATIVELY IMMOBILE, AND THE ASSEMBLY
OF WHICH TAKES MONTHS - SOMETIMES
YEARS - CAN WORK IN ONE LOCATION
FOR AN EXTENDED PERIOD OF TIME
(PREFERABLY SEVERAL YEARS).

THE UNITS ARE HUGE, AND TRANSPORTA-
TION TO DIFFERENT SITES IS A MAJOR
PROJECT IN PREPARATION, EXECUTION,
AND FUNDS.

THERE IS A MINIMUM CAPACITY REQUIRE-
MENT FROM CONTINUOUS SYSTEMS. IT
SHOULD BE SET A 2,000 TO 3,000 T/H.

THE SECOND METHOD IS THE "DISCON-
TINUOUS" OR "SHOVEL AND TRUCK"
METHOD.



OPEN-CAST-MINING

IT IS NOT (OR NOT MUCH) SENSITIVE TO THE KIND OF MATERIAL TO BE MINED. HARD ROCK IS SHOT, PROPER PROTECTION AGAINST ABRASIVENESS OF MATERIAL CAN BE APPLIED TO PROTECT MACHINERY. THE METHOD IS APPLIED IN A VERY HIGH PERCENTAGE OF "HARD-ROCK MINING" OPERATIONS.

MOBILITY OF MACHINES IS BETTER THAN IN THE CONTINUOUS METHOD. FREQUENT CHANGES OF WORKING PLACES IN THE MINE OR EVEN FROM MINE TO MINE ARE POSSIBLE. THIS IS NECESSARY WHEREVER THE NEED OF "MATERIAL-BLENDING" ARISES AND IN ALL CASES WHERE MACHINES HAVE TO BE MOVED OUT FOR BLASTING.

CAPACITIES OF DISCONTINUOUS LOADING MACHINES SPAN FROM A FEW HUNDRED TO ABOUT 3,000 T/H. HIGHER CAPACITIES HAVE TO BE ACHIEVED BY MULTIPLE SYSTEMS.

OPEN-CAST-MINING

THE METHOD IS WELL PROVEN, FLEXIBLE, AND IT DOMINATES OPEN-CAST-MINING. ITS MAIN DISADVANTAGE LIES IN THE COMPARATIVELY HIGH HAULING COST COMPARED TO CONVEYORS. ESPECIALLY IF IT EXTENDS OVER GREAT DISTANCES OR INCLUDES UPHILL HAULAGE.

THEREFORE, COMBINED SYSTEMS OF "DISCONTINUOUS LOADING AND CONTINUOUS TRANSPORTATION" ARE DEVELOPED TODAY.

IN THIS PRESENTATION, ONLY THE DIFFERENT METHODS AND EFFICIENCIES OF MEANS APPLIED IN THE "DISCONTINUOUS SYSTEM" WILL BE COMPARED AND DISCUSSED.

CONVENTIONAL LOADING MACHINES IN HARD-ROCK OPEN-CAST-MINING OPERATIONS ARE:

- CABLE SHOVELS AND
- WHEEL LOADERS.

FOR PRODUCTION PURPOSE IN MINING, MACHINES SMALLER THAN 4m³ (5 CYD) CAN BE DISREGARDED.

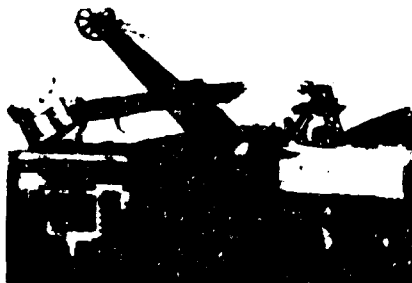
OPEN-CAST-MINING



THE CABLE SHOVEL

THE CABLE OR "POWER SHOVEL" HAS BEEN BUILT FOR MORE THAN 100 YEARS. ITS SIZE RANGES UP TO A BUCKET CAPACITY OF 38 m^3 (50 CYD) TO SERVE THE COMING GENERATION OF 300-TON TRUCKS. (STRIP SHOVELS ARE 4 BUILT TO 115 m^3 (150 CYD)).

PRIME-MOVER HAS BEEN STEAM, TODAY IT IS ELECTRICITY WITH WARD-LEONARD SETS OR THYRISTOR CONTROL UNITS. SMALLER UNITS ARE DIESEL OR DIESEL-ELECTRICALLY POWERED.



IT IS MAINLY DUE TO THOSE DRIVEN UNITS THAT CABLE SHOVELS ARE VERY 5 HEAVY AND EXPENSIVE.

THE WEIGHT OF MODERN ELECTRIC CABLE SHOVELS RANGES IN THE AREA OF 40 t/m^3 (50 T PER CUBIC YARD) OF BUCKET CAPACITY.

OPEN-CAST-MINING

TODAY'S PRICES EX FACTORY (81) ARE RUNNING AT APPROXIMATELY US-\$ 115.000 PER CUBIC YARD OF ROCK BUCKET. OWNING AND OPERATING COST LEAD TO US-\$ 0.12 TO 0.16 PER TON LOADED. (FIGURES GIVEN ARE SUBSTANTIATED IN TABLES BELOW).

THE STRONG PLUSSES OF THIS TOOL ARE:

- IT IS VERY WELL PROVEN
- LONGEVITY
- DEPENDABILITY
- HIGH DIGGING FORCES
- VERY WELL APPLICABLE IN TOUGH ROCK.

THE SHORTCOMINGS ARE:

- EXPENSIVE (HIGH PRIME INVESTMENT) WHICH LEADS TO HIGH OWNERSHIP COSTS
- LARGE UNITS, RELATIVELY IMMOBILE DUE TO WEIGHT, ELECTRIC CABLE, AND TYPE OF UNDERCARRIAGE
- BIG UNITS ARE HARDLY TRANSFERABLE FROM MINE TO MINE
- CERTAIN SHORTCOMINGS IN THE DIGGING CYCLE.

OPEN-CAST-MINING



THE WHEEL LOADER

15 TO 20 YEARS AGO, THERE WAS THE ADVENT OF ANOTHER LOADING TOOL IN THE MINING INDUSTRY:

6 THE WHEEL LOADER.

IT IS BUILT TODAY IN SIZES UP TO 19 m^3 (25 CYD). ITS WEIGHT IS ONLY AROUND 15 t/m^3 (20 TONS PER CUBIC YARD). DRIVE SYSTEM IS DIESEL-HYDRODYNAMIC OR DIESEL-ELECTRIC. THE POWER INSTALLED IS 38 kW/52 PS PER YARD, AND TODAY'S PRICE RANGE AT US-\$ 27.000 PER CUBIC YARD (FOB USA).

IT AIMED AT SOME OF THE SHORTCOMINGS OF THE POWER SHOVEL:

- ITS PURCHASE PRICE IS COMPARATIVELY INEXPENSIVE (ONLY 1/3 OF A CABLE SHOVEL)
- IT IS VERY MOBILE
- IT CAN TRAVEL ON ITS OWN WHEELS AT AUTOMOBILE SPEED FROM JOBSITE TO JOBSITE.

OPEN-CAST-MINING

THE MACHINE'S ADVANTAGES HAS CLEARLY BEEN STATED IN THE BEGINNING; ITS WEAK AREAS ARE:

- WEAK DIGGING ABILITY
- TYRE COST
- COMPARATIVELY HIGH MAINTENANCE COST IN HARD-ROCK APPLICATION

OWNING AND OPERATING COST CAN LEAD- AS WE WILL SEE - ESPECIALLY IN TOUGH HARD-ROCK APPLICATIONS TO COMPARATIVELY HIGH LOADING COST.

THE HYDRAULIC EXCAVATOR

THE FIRST FULLY HYDRAULIC EXCAVATOR WAS BUILT IN 1954.

TODAY'S SIZES RANGE FROM 10 T TO 270 T SERVICE WEIGHT.

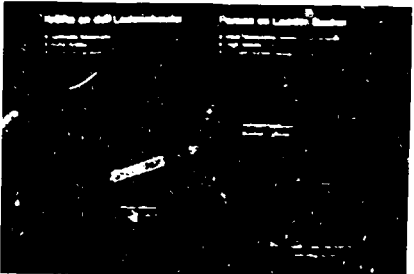
THE BUCKET SIZES RANGE FROM ABOUT 1 M³ UP TO 21 M³ (1,3 CYD UP TO 7 28 CYD) CAPACITY.



OPEN-CAST-MINING

COMPARISON BETWEEN POWER SHOVELS AND WHEEL LOADERS:

DIGGING FORCE:



THE DIGGING CAPABILITY IS DIRECTLY INFLUENCED BY THE FORCE ACTING ON A SPECIFIC LENGTH OF CUTTING EDGE, I.E. THE "LINE PRESSURE" ON THE


8 BUCKET LIP.

THE LINE PRESSURE OF WHEEL LOADERS IS BY FAR INFERIOR TO THAT OF POWER SHOVELS. IT IS DUE TO

- LESSER WEIGHT OF WHEEL LOADERS COMPARED TO POWER SHOVELS OF THE SAME CAPACITY; WHICH RESULTS IN LESS FORWARD THRUST AND LESS STABILITY
- CUTTING EDGES OF WHEEL LOADERS HAVE TO EXCEED THE TOTAL WIDTH OF THE MACHINE IN ORDER TO PROTECT THE TYRES. BUCKETS OF WHEEL LOADERS, THEREFORE, ARE WIDER THAN COMPARATIVE POWER-SHOVEL BUCKETS - REDUCING LINE PRESSURE.

OPEN-CAST-MINING

THE POWER SHOVEL IS "STATIONARY LOADING TOOL". THIS MEANS, WHILST LOADING THE UNIT IS STATIONARY. MOVING TO PENETRATE INTO THE ROCK-PILE ARE THE MEMBERS OF THE LINK-AGE ONLY. THE SUPERSTRUCTURE SWINGS IN A BEARING DEVICE TO CARRY DUG MATERIAL FROM THE ROCK-PILE TO THE LOADING TARGET. THE PROCESS IS DESIGNED FOR MINIMUM WEAR AND TEAR ON THE MACHINE AND MINI ENERGY CONSUMPTION.



WHEEL LOADERS ARE "MOVING LOADING TOOLS", I.E. THE WHOLE MACHINE MOVES DURING THE LOADING CYCLE: FORWARD INTO THE PILE, BACKWARD AND TURNING TO GET INTO UNLOADING POSITION, FORWARD TO UNLOAD, BACKWARD AND TURN TO GET IN LOADING POSITION.

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THEREFORE, TILL TODAY POWER SHOVELS ARE THE DOMINATING LOADING TOOL IN OPEN-CAST-MINING.

OPEN-CAST-MINING

THE HYDRAULIC SHOVEL

CONCEPT FOR A "BETTER" MACHINE



A "BETTER" MACHINE WOULD, THEREFORE, HAVE ITS LOGICAL PLACE JUST BETWEEN THE FEATURES OF POWER SHOVEL AND WHEEL LOADER.

IT SHOULD HAVE/OR BE

- LESS EXPENSIVE THAN THE POWER SHOVELS, I.E. BUILT SIMPLER/
HAVE LESS WEIGHT PER CUBIC YARD
- SHOULD BE MORE MOBILE AND HAVE BETTER GRADEABILITY THAN POWER SHOVELS
- PRESERVE THE DIGGING FORCE AND ABILITY TO HANDLE TOUGH MATERIAL OF A POWER SHOVEL, WHILST AVOIDING CERTAIN SHORT-COMINGS OF ITS DIGGING CYCLE
- AVOID THE HIGH MAINTENANCE AND TYRE COST OF A WHEEL LOADER
- BE MUCH LIGHTER THAN A POWER SHOVEL AND BUILT IN MODULES SO THAT TRANSPORT TO A JOBSITE AND FROM ONE SITE TO ANOTHER WOULD NOT POSE BIG PROBLEMS.

OPEN-CAST-MINING

HYDRAULIC MINING SHOVELS (HMS)

THE ADVENT OF THE HYDRAULIC SHOVEL IN 1954 OPENED THE WAY TO THE DESIRED ALTERNATIVE.

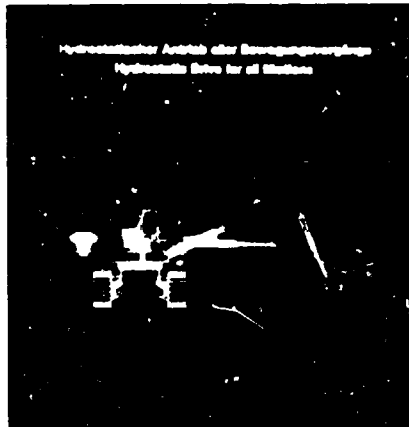
- IT IS ROTATING (SWING) MACHINE
- IT IS BUILT QUITE SIMPLE
- IT PRESERVES AND IMPROVES DIGGING CAPABILITY TO A HIGH DEGREE.



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BASICALLY, IT CONSISTS OF:

- ENGINE - HYDROSTATIC PUMP UNIT AS PRIME MOVER (ENGINE CAN BE DIESEL OR ELECTRIC)
- HYDRAULIC CYLINDERS TO ACTUATE FORWARD AND BACKWARD MOVEMENTS OF THE LINKAGE
- HYDRAULIC (HYDROSTATIC) MOTORS TO ACTUATE SWING AND PROPEL MOTIONS.



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OPEN-CAST-MINING

THE ENERGY-TRANSMISSION SYSTEM
IS HYDROSTATIC - AS OPPOSED TO
HYDRODYNAMIC. THIS MEANS,
PRESSURIZED OIL IS USED TO MOVE
PISTONS IN CYLINDERS AND MOTORS,
NO "FLOW MOTORS" ARE UTILIZED. THE
SYSTEM HAS A VERY HIGH DEGREE OF
EFFICIENCY - COMPARABLE TO ELECTRIC
SYSTEMS, MUCH HIGHER THAN HYDRO-
DYNAMIC SYSTEMS.

SIZES OF HYDRAULIC MINING SHOVELS

ON THE MARKET AND WORKING IN THE
MINES ARE TODAY HYDRAULIC MINING
SHOVELS WITH A BUCKET CAPACITY OF
6 - 15 m³ (8 - 20 CYD). THEIR
RESPECTIVE SERVICE WEIGHTS ARE 60
TO 280 TONS. PRIME-MOVER POWER IN-
13 STALLED VARIES FROM 250 TO 1400 HP.



THE DEMAG HYDRAULIC MINING SHOVELS
ARE AS FOLLOWS:

- H 51
50 TONS SERVICE WEIGHT,
BUCKET CAPACITY UP TO 3,0 m³
(4 CYD)

OPEN-CAST-MINING



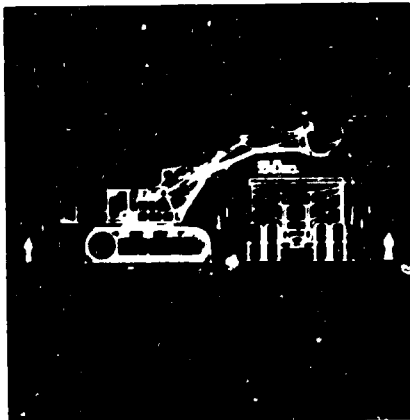
- 14 - H 71
77 TONS SERVICE WEIGHT,
BUCKET CAPACITY UP TO 5.5 M³
(7 CYD)



- 15 - H 121
115 TONS SERVICE WEIGHT
BUCKET CAPACITY UP TO 7.5 M³
(10 CYD)



- 16 - H 241
270 TONS SERVICE WEIGHT,
BUCKET CAPACITY UPTO 14 M³
(18.5 CYD)



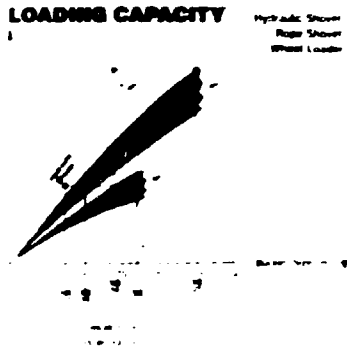
- 17 SLIDE 17 SHOWS THAT THIS MACHINE
IS EDEALLY MATCHED FOR LOADING
THE 150 T DUMPERS.

OPEN-CAST-MINING

PRODUCTION

THE THREE LOADING SYSTEMS TO BE COMPARED IMPLY DIFFERENT LOADING TECHNIQUES, THUS PRODUCING WIDELY VARYING CYCLE TIMES.

IT IS ACCEPTED THAT THE HYDRAULIC SHOVEL DUE TO ITS DIGGING CHARACTERISTICS CYCLES FASTEST, THE WHEEL LOADER DUE TO ITS LOADING TECHNIQUE SLOWEST.



IN DIFFERENT STUDIES IT HAS BEEN ESTABLISHED THAT THE AVERAGE CYCLE TIME OF THE THREE MACHINES IS AS FOLLOWS:

HYDRAULIC MINING SHOVEL :
CABLE SHOVEL = 1 : 1.3
CABLE SHOVEL : WHEEL LOADER =
1 : 1.7
HYDRAULIC MINING SHOVEL :
WHEEL LOADER = 1 : 2.0

OPEN-CAST-MINING

THESE DIFFERENT CYCLE TIMES PRODUCE DIFFERENT HOURLY PRODUCTION COSTS OF MACHINES WITH THE SAME BUCKET SIZE.

Comparison Costs - 1000 Tons Per Hour

Ownership Costs	Machine Model
	7500
	8000
	8500
	9000
	9500
	10000
	10500
	11000
	11500
	12000

MACHINE SIZES OF EQUAL HOURLY PRODUCTION HAVE TO BE COMPARED IF LOADING COSTS ARE EVALUATED. THE RESULTS ARE SHOWN IN TABLES

19 2 AND 3.

Operating Costs

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SUMMARY

THE HEAVY MINING SHOVEL HAS A GREAT FUTURE IN STRIP-MINING APPLICATIONS, BECAUSE ...

- IT PERFORMS ECONOMICALLY
- IT CAN QUICKLY BE ADAPTED TO CHANGING MINING CONDITIONS
- IT IS NOW A TECHNICAL FULLY SEASONED MINING TOOL.

OPEN-CAST-MINING

DEPENDING ON THE QUARRYING METHOD LOADING SHOVELS (I.E. BULLCLAM BUCKETS) OR BACKHOE ATTACHMENT CAN BE USED. IN GENERAL, THERE ARE FOUR TYPICAL APPLICATIONS.



- 21 1.) EXCAVATOR AND DUMPER IN FRONT OF THE FACE. DIRECT EXTRACTION WITHOUT BLASTING IS POSSIBLE.

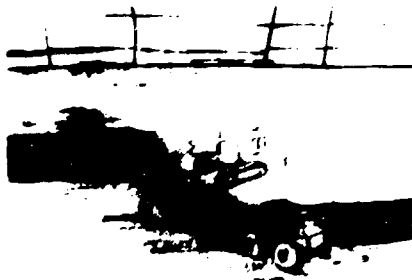


HERE IS DEMAG H 51 WITH BULL-CLAM.

ANGLE OF SWING OF 90° ONLY SHORT CYCLE TIME - BOTH SHOVEL OPERATOR AND DRIVER OF HAULING FACE EACH OTHER, PERMIT A HIGH LOADING PRODUCTION OF AS MUCH AS 500 T/H.

22

- 2.) HYDRAULIC EXCAVATORS AS BACKHOE STANDING ON THE ROCK PILE. DUMPERS SPOTTED ON THE FLOOR BELOW.



23

ADVANTAGES:

GOOD VISIBILITY - SELECTIVE DIGGING - SHORT CYCLE TIME - REDUCED DUMPING HEIGHT - THIS ALTOGETHER GIVES A HIGH PRODUCTION.

OPEN-CAST-MINING



24

THE DEMAG H 51 WITH BACKHOE ATTACHMENT IN THIS APPLICATION.



25

DEMAG H 71 WITH BULLCLAM, WORKING FROM THE FOOT OF THE FACE, AVERAGE LOADING PRODUCTION 700 T/H.



26

3.) THE BACKHOE EQUIPPED EXCAVATOR ABOVE THE BENCH, WITH DUMPERS POSITIONED BELOW.

ADVANTAGES:

HIGH TEAR-OUT PRYING FORCES -
SELECTIVE DIGGING - GOOD VISIBILITY - ACCURACY, SAFETY AND SPEED - MAXIMUM PRODUCTION.



27

DEMAG H 71 WITH BACKHOE ATTACHMENT WORKING IN THIS APPLICATION.

OPEN-CAST-MINING



28

THE H 121 WITH BULLCLAM WORKING FROM THE FOOT OF THE FACE UPWARDS, AVERAGE PRODUCTION 1200 T/H.



29

4.) THE FOURTH APPLICATION: EXCAVATOR AND DUMPER ARE POSITIONED ABOVE THE FACE, ALLOWING EXTRACTION TO CONTINUE EVEN WHEN FOUL WEATHER CONDITIONS MAKE IT IMPOSSIBLE TO WORK AT THE LOWER LEVEL.



30

THE DEMAG H 121 WITH BACKHOE ATTACHMENT IN THIS POSITION.



31

THE DEMAG H 241 WITH BULLCLAM WORKING FROM THE FOOT OF THE FACE, AVERAGE LOADING PRODUCTION 2300 T/H.

OPEN-CAST-MINING



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DEMAG H 241 WITH BACKHOE
ATTACHMENT ALLOWING HIGH
PRODUCTION IN THIS WORKING
APPLICATION.

AS SEEN IN THE LAST SLIDE, THE BIG
HYDRAULIC EXCAVATORS ARE ALSO
WORKING IN COAL OR ON OTHER OPEN
CAST MINING JOBS SUCH AS THE
REMOVAL OVERBURDEN AND ORE MINING.
SPECIAL BUCKET ARE AVAILABLE, FOR
EXAMPLE A 21 M³ (28 CYD) BULLCLAM
ON H 241 FOR COAL MINING.

GENTLEMEN,

THIS WAS IN SHORT A GENERAL VIEW
OF HYDRAULIC EXCAVATORS WORKING
IN QUARRIES AND OPEN CAST MINING.

THANK YOU FOR YOUR ATTENTION.



